POWER

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Every-day Etiquette

MOST of the books on etiquette devote their attention to weddings, balls, dinners and funerals.

I wish somebody would write a book on the etiquette of every-day life.

I should like to see the gaff of social condemnation put into the rowdy who elbows others aside, clambers into a train and plunks himself into a seat with a vehemence that almost bounces his neighbor out; into the thoughtless fellow who has the window seat and spreads his newspaper so as to shut off all the light; into the loud-mouthed individual who distracts a whole carful of people with accounts of his prowess in golf, the qualities of his new car or the gruesome details of his recent illness.

I should like to see the seriousness of his offense brought home to him who coughs or sneezes the emanations of his affected bronchial system, not into his handkerchief but into the air that I must breathe.

I should like to see the mob of frenzied clock-punchers who with their fronts crowded into the backs of those ahead of them block the car aisle, taught to disembark in a proper and orderly manner. One who has remained seated until the train stops will often stand until the entire procession has passed if he waits for somebody to pause courteously and allow him a place in it, and such courtesy is more likely to come from a woman than a man. On the other hand, you will see those who push their way out, careless as to whether they are separating a lady from her escort or butting into a party of friends.

I should like to see the ill-bred cub who stops in the middle of a crowded stairway or passage to light a cigarette get what his fellow travelers would prescribe for him.

I should like to have somebody tell what I think of her—for I dare not—the lady for whom I courteously step aside to allow to precede me into an elevator, and who then deliberately backs up against the wall close to the door so that I have to excuse myself and crowd around her to get in.

I should like to have made to see himself as others see him the individual who marches up to the head of a waiting line at a ticket window or dining car and picking out some unoffensive looking person steps presumptuously in front of him and into precedence of all who are behind.

I wish there were a special limbo—and that he did not have to wait until he died to get into it—for the boob who goes along the street shedding fruit skins, nut shells, cigar butts, paper scraps and other personal offal.

The real essence of all etiquette is regard for the sensibilities and feelings, the pleasure, comfort and rights of others. It will make more difference to the general well being if one indulges in such breaches of good manners as the foregoing than as if he wore the wrong necktie to a wedding or ate his fish with the ice-cream fork.

F. R. Low

Some Unusual Steam Plants in Tuscany

Power Development in Italian Department of Tuscany—Lignite Fuel Used in Boilers and Gas Producers at San Giovanni Valdarno— Lardarello Plant Gets Power and Boric Acid from Natural Steam

BY EMANUEL HAHN

THE fuel difficulties of Italy have been often discussed and are well known. To sum them up briefly, Italy is devoid of coal and oil and wood is precious. Luckily, there are plentiful supplies of "white coal," and these are being developed to a great extent. The greatest installations are in the north, but the backbone of the Apennines, extending through the country southward is the origin of many falls that have been and are being exploited.

Besides this, local peculiar fuels are used. If we consider the conventional boot to which Italy is likened, we find just above the knee the Province of Tuscany, known to the world because of the ancient prowess of its cities (Pisa, Florence, Siena, Leghorn and many others) in many fields. Fig. 3 is a detailed map of this province and its surrounding territory. Within its boundaries are found three unusual "fuels"—peat, lignite and the heat of the earth. Near Lucca are two plants distilling peat and using the resultant gas in internal-combustion engines driving generators. One of these has been in operation ten years; the other will soon be started up. The plants using the other fuels will be described.

Beginning at Terni, to the South (see map), where there is a large hydro-electric installation, lines run north into Tuscany, to San Giovanni Valdarno, where is located the plant of the Societá Mineraria ed Elettrica del Valdarno. This company supplies current for all

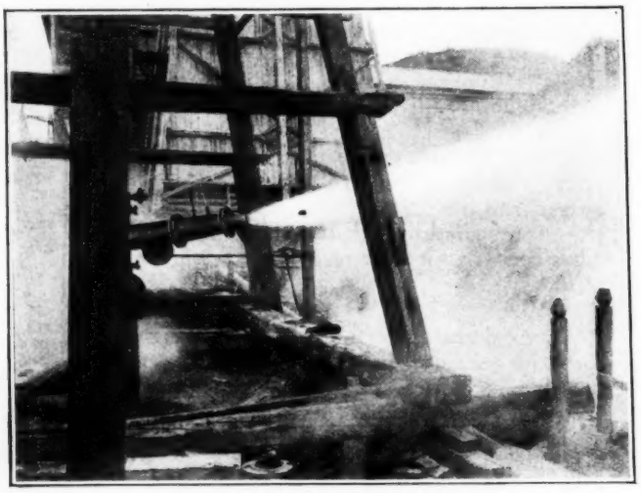


FIG. 1—AN OPEN SOFFIONE (NATURAL STEAM WELL)

purposes to the cities of Florence, Prato, Pistoja and surrounding country. A second line runs to Siena, connecting there with the lines of the Societa Boracifera de Lardarello, whose lines supply the district around Lardarello. Another branch of this company's lines runs to Leghorn, there connecting with the lines of the Societa Ligure Toscana del Elettricitá. This company runs lines northwest into Liguria and connects with the great hydro-electric developments of Lombardy, which lies north of Liguria. Another of these lines runs from Leghorn to Prato, there connecting with the lines of the Societa Mineraria ed Elettrica del Valdarno.

The plant of the Societa Mineraria ed Elettrica del Valdarno is the only large lignite plant in Italy. Through the kindness of Signor Benozzi, chief engineer, I was permitted to visit the plant, where Signor Legnaioli, engineer in charge, put everything at my disposal. As the name of the company indicates, it is a mining and power company. The plant is located at the mines, at Castelnuovo, five miles from the railroad station of San Giovanni Valdarno. The mine mouth is about one mile from the "centrale," or power house. The lignite produced for shipment is carried in an overhead trolley to the loading tracks; that for the plant is hauled in forty-ton all-steel Koppel cars—the largest cars I have seen in Europe. These are of hopper-bottom type and discharge into a conveyor which lifts the lignite to an overhead storage bin in boiler room No. 1 (Fig. 4). Large lumps are crushed to a maximum of a 4-in. cube. The conveyor, on its return, lifts the ashes to small narrow-gage Koppel cars of one cubic-yard capacity. These cars also carry the necessary lignite to boiler room No. 2. The lignite, as fed to the furnaces, has an analysis of 50 per cent water and 15 per cent ash.

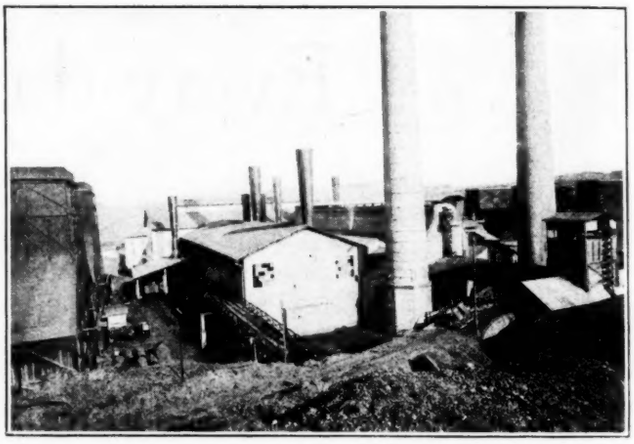


FIG. 2—LIGNITE-BURNING PLANT AT CASTELNUOVO, SHOWING BOILER HOUSES, COOLING TOWERS AND COAL-HANDLING EQUIPMENT

Boiler Room No. 1, now in use, contains ten 5,400-sq.ft. water-tube boilers, of standard design, with integral superheaters. Steam is generated at 175 lb. and 620 deg. F. The apparatus was built in 1911. The furnaces are arranged for the fuel to fall in hoppers from the overhead supply and thence directly in a heap on the bars, where it burns with a yellow, smoky flame. The settings leak air, no attempt being made to close auxiliary openings. The stacks are of brick, natural draft, without CO_2 recorders or draft gages.

Boiler room No. 2, now held as reserve, contains three Tosi boilers and six B. & W. The first of the Tosi

boilers (6,000 sq.ft.) was designed for lignite, fed from overhead hoppers. It has a double furnace, one on each side, and is practically two boilers. This boiler has a superheater and economizer and is provided with a venturi-type stack with forced draft, the fan being constructed so that it can be driven either by steam or electricity.

The remaining two Tosi boilers are gas-fired. The gas is produced as hereinafter described and enters through a checkerwork, mixing with air in excess, then passing over a bed of burning lignite that heats the checkers and uses the excess air. The boilers are of simple water-tube construction, each with two drums, have a total heating surface of 3,200 sq.ft. each, and are equipped with superheaters. They are served by Pratt steel stacks.

The other boilers are similar to those in boiler room No. 1 except that they are smaller (4,000 sq.ft.) and have, in addition to superheaters venturi-type steel stacks with forced draft.

The water used for the plant comes from a small stream that flows alongside. The quantity available is so small at times that the plant can produce only half of the power of which the machines are capable. This mountain stream can furnish enough water in the spring, but in the summer the quantity falls and the temperature mounts. The boiler-feed water is treated with lime and soda. The circulating water is cooled in five large cooling towers.

The gas producers are of two designs. The original installation was a battery of six Stapf (Austrian) steel generators. The entire load of the charge is borne by the grate bars, which are insufficient for the load and often fail. Replacement requires the shutting down of the unit. Stirring is also difficult. To obviate this

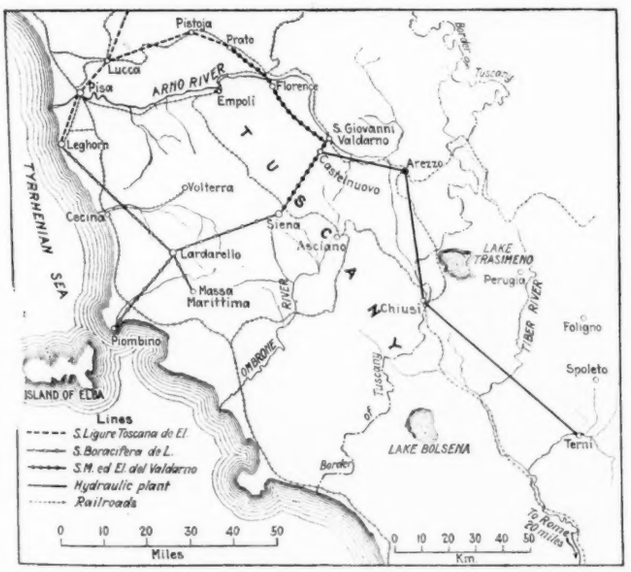


FIG. 3—MAP OF DEPARTMENT OF TUSCANY SHOWING TRANSMISSION LINES

constant annoyance, a concrete producer has been designed by the company, which is still in the experimental stage, several changes being contemplated.

The oldest equipment in the generating room, now held as a reserve, consist of three engine-generator sets all identical. They are 2,000-hp. triple-expansion, four-cylinder machines, running condensing at 94 r.p.m. Current is generated at 6,000 volts three-phase 50-cycle.

Another reserve consists of two identical units (*A* and *D* of Fig. 4) of German make, each consisting of an impulse turbine direct connected to a 6,000-kva. 6,000-volt three-phase 50-cycle 1,500-r.p.m. generator with direct-connected exciter.

For regular service there are three units. Two (*B* and *C*) are identical, consisting of semi-impulse semi-

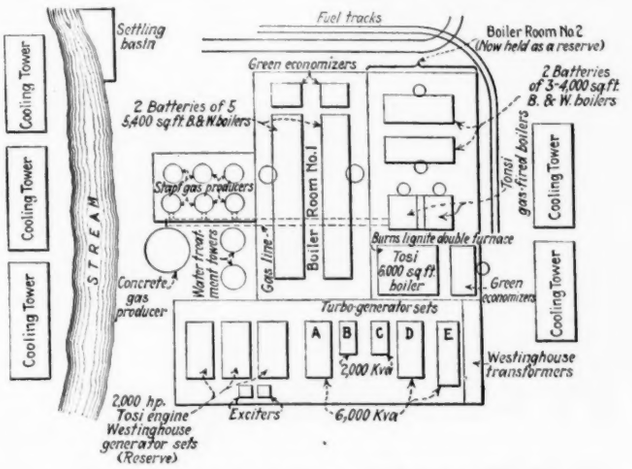


FIG. 4—PLAN OF LIGNITE-BURNING PLANT AT CASTELNUOVO

reaction turbines with 2,000-kva. generators. The third *E* is a Parsons-type turbine, with a 6,250-kva., 1,500 r.p.m. generator. The electrical characteristics are the same as for the other units.

The power factor on the lines averages 0.6. Therefore there are floated on the lines three synchronous motors, by which the generator power factor is maintained at 0.88 to 0.90.

The present capacity, limited by the water supply, is 10,000 kva. Plans have been drawn to augment this so as to utilize the entire lignite production of the mines at the power house, which will entail enlarging the plant to produce 80,000 kva. This project will be promoted in the near future.

By far the most interesting plant in Italy is the natural steam plant of the Societa Boracifera di Lardarello[1] The plant is not yet fully developed, and as it is a pioneer, its history must be discussed.

Every elementary textbook on chemistry and geology, in commenting on the occurrence of elements, describes the natural presence of boron as boric acid in the steam springs of Tuscany. These springs are found in the Province of Pisa. The first important commercial enterprise was started at a new village in the vicinity of Montecerboli by the Lardarel Company in 1818. This was named Lardarello in honor of its founders. Several small enterprises also started in the vicinity, the available area being about 45 square miles, and all have been consolidated in the Societa Boracifera di Lardarello.

The steam springs occur in two different forms: in small craters, called "lagoni," filled with condensed steam which is kept at the boiling point by further streams of steam, and in jets of steam or boiling water direct from the earth, called "soffioni." The steam from the "soffioni" contains boric acid and gases, including carbon dioxide, nitrogen, hydrogen sulphide and helium as well as rarer gases. Ammonia is found in varying quantities in different locations.

[1]Short articles on this development appeared in the Jan. 13, 1920 and June 1, 1920, issues.

In all the company operates eight neighboring plants for the extraction of boric acid. Besides Lardarello, there are plants at Castelnuovo, Sasso, Lago, Travale, Monterotondo, Sarrazzano and Lustignano. The process is simple. The proportion of boric acid in the natural water is two to three parts per thousand. This water is conveyed by special piping to the Caldie Adriane, consisting of shallow basins arranged in series.

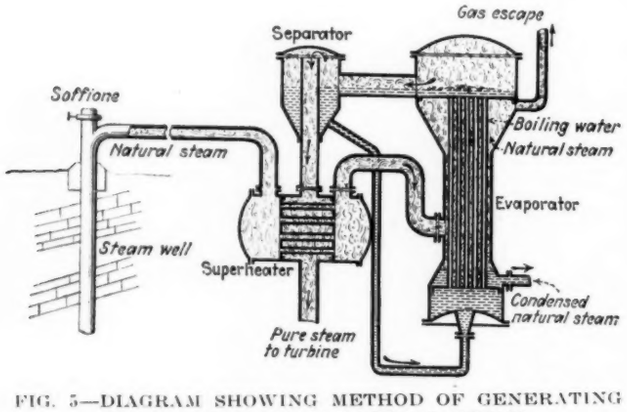


FIG. 5—DIAGRAM SHOWING METHOD OF GENERATING PURE STEAM FROM NATURAL STEAM

The series is inclined, the water passing from one to the other, and the whole being heated by natural steam passing through a flue underneath the basins. By this evaporation a concentration with a boric acid content of 8 per cent or higher is reached. The strong solution is then cooled, boric-acid crystals (of varying purity, reaching as high as 99 per cent) separating out. All refining is carried on at Lardarello, boric acid, borax and ammonium carbonate being marketed.

The natural production of steam has been insufficient since the inception of this process. To supplement it, there has grown up a special technique of well drilling, which gives the artificial "soffioni." The tools are heavy steel chisels, attached to a rigid system of iron rods, the whole of which is lifted and dropped 18 to 20 strokes per minute, a slight rotation taking place with each stroke. This makes a cylindrical hole, which is lined with iron tubing, autogenously welded in place. Débris is removed by special tools. Steam is found at a depth of 65 ft. or even less below the surface, and further drilling must proceed with great care, a specially trained body of workmen being used. The diameters vary from 8 to 15 in., and larger diameters are soon to be used.

When the proper depth is reached, which is determined by the experience of the man in charge, the opening is cleared of débris and water by explosion. A piston, roughly conforming to the bore, is forced down the hole, then rapidly withdrawn by an electric winch. The well then erupts volcanically, often destroying the drilling derrick and spouting mud and small stones for several minutes. Then the hissing of dry steam begins, and the well is "in."

The depth of these wells varies; 200 ft. is the minimum, but recent borings have reached a depth of 560 ft. The pressure varies, the highest recorded being 44 lb. (with closed valves) at Lardarello. The pressure of a well, with constant valve opening, is practically constant. The mean pressure, with maximum output, is 15 lb. The output at Lardarello varies from 600 to 66,000 lb. per well, the total used being 220,000 pounds.

The entire district lies in the volcanic portion of the metal bearing hills of Tuscany. At Massa Maritima, not far away, are important iron and copper pryites mines. Several peculiar minerals such as borate of ammonia and orthoboric acid occur in the region of the "lagoni."

The first attempt to use the natural steam for power production was in 1897, when the natural steam was used to generate pure steam in a small boiler, and the resultant pure steam worked a small engine. In 1905 Prince Ginoi Conti, then general director of the Lardarello works, and now chairman of the Societá, began experiments in the use of natural steam in an engine. The interest which the Prince then took, which has broadened with the subsequent successes, has been in a large measure the cause of these successes. The results of the first experiments were very satisfactory, and the next year a large engine was installed and driven directly by natural steam, the resultant power being used to drive a small generator for plant use.

In 1912, a 2,500-kw. turbo-generator was installed. The original intention was to drive this by means of natural steam, but the presence of uncondensable gases made the production of a sufficient vacuum difficult. There was also the question of the effect of the chemicals in the steam on the blading of the turbine. For this reason the natural steam was used to generate pure steam for the turbine. The current was generated at 4,000 volts three-phase 60-cycles and distributed at 16,000 volts to two of the company's plants, as well as Volterra and Saline. A portion was used at Lardarello at 220 volts.

In 1914 the installation of three 2,500-kw. units was authorized, and after vexatious delays in 1916, due to the war, these were completed. Two are working, one being held as reserve. The original unit, of 250 kw., has been moved to Lago, where it is used in experiments toward improvements in design and in method.

The existing plant will be described in the order of the use of its elements. The evaporators are shown

FIG. 6—VIEW OF LARDARELLO, SHOWING POWER STATION AND COOLING TOWERS

diagrammatically in Fig. 5. Each element consists of an evaporator and a superheater, the natural steam passing first through the superheater, then the evaporator. The evaporator consists of 300 tubes, 1.18 in. in diameter and 23 ft. long. The water is inside, the natural steam circulating outside. The uncondensed steam and contained gases pass to a collector, where the CO_2 is extracted. Considerable difficulty has been experienced with the tubes. Iron cannot be used, because

deposits of iron sulphide are formed, and aluminum, which is used, breaks rapidly because of the vibration caused by the nascent steam.

The pure steam passes through a separator, one separator serving two elements. Eight elements are sufficient for each turbine. Each element produces about 13,200 lb. of pure steam per hour. The pressure of the natural steam is 15 lb. and the pressure of the pure steam is 7 to 8 lb., so it is clear that if the natural steam could be used direct, there would be a great increase in efficiency throughout. The minor difficulty—that of chemical action on the blading—has been solved by special alloys, but the great difficulty is the presence of the gases. On account of the low initial pressures, any fluctuation of vacuum in the condensers means large variation in current output. Indeed, one of the company's great difficulties has been in minor variations of cycle, particularly in the current coming from Terni and Valdarno. Though nominally 50 cycle, it has on occasion fallen as low as 43, which means that the motors driving the condenser pumps have slowed 14 per cent, with resultant fall in vacuum. This difficulty has now been obviated. It is with the problem of removing the gases that the company's engineers have occupied themselves at Lago, and it may be that soon there will be additional information to offer.

Feed water can be obtained from the condensate from the condenser, or from the condensed natural steam from the evaporators. The latter is, of course, not so pure, but as it is at 145 deg. F. and no harmful results from its use have been noticed, it is more advantageous. The feed pumps are actuated by natural steam.

The turbines are extremely interesting, being specially designed for operating on large quantities of low-pressure steam. The inlet valves are designed to handle the 77,000 lb. of steam per hour that the average output demands. The generators are capable of 3,000

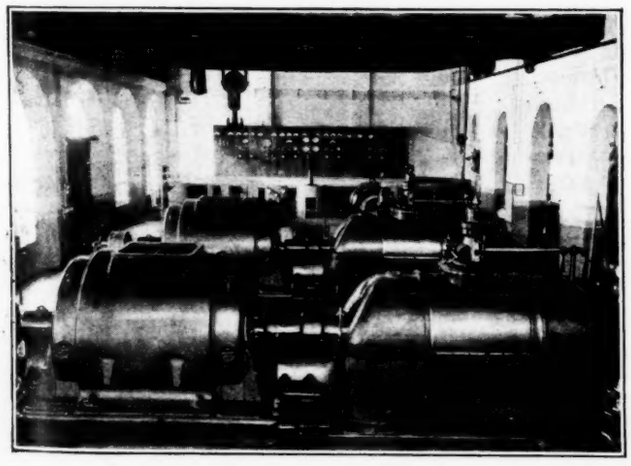


FIG. 7—INTERIOR OF POWER STATION AT LARDARELLO

kw., but the average load is only 2,500 kw. Former figures regarding consumption have been changed, and the present records are not available for publication. As previously stated, the pressure of the pure steam at the evaporator is approximately 7 lb. Losses in the piping make the pressure at the inlet only 3.5 lb. The turbines were designed and built by Messrs. Franco Tosi, of Milan, Italy. They are of the Parson double-flow reaction type. Of the eight rows of blades, five are made of brass, while the last three rows are constructed of steel containing five per cent of nickel.

Surface condensers, each with 3,000 tubes (0.865-in. diameter by 14 ft. 9 in. long) are used. The water is driven through the tubes by centrifugal pumps direct connected to motors, whose speed variations, due to cycle changes, have been mentioned. These motors are each of 300 hp. Hydraulic ejectors are used below the condensers in place of air pumps. The cool water passes through these to the centrifugal pumps, and leaving the condensers passes to the cooling towers.

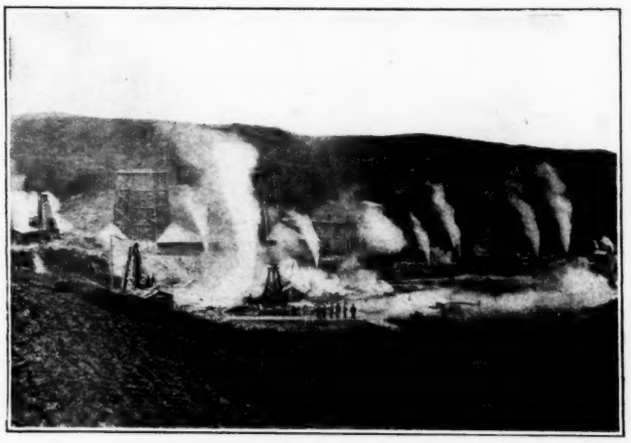


FIG. 8—VIEW OF LARDARELLO SHOWING SOFFIONI OPEN FOR MEASUREMENT OF TOTAL STEAM OUTPUT

These are of natural-draft type, capacity 1,200 cubic meters per hour. Three are in use. The fall in temperature is 18 deg. F. The water is collected in reservoirs and the condensed natural steam treated to remove the boric acid.

The alternators are all 4,000-volts three-phase 50-cycle at 3,000 r.p.m. Air filters, which have proved their value here, are used. There are four 36,000-volt lines: One to Siena, connecting with the Societa Mineraria ed Elettrica del Valdarno lines; one to Leghorn, connecting with the Societa Ligure Toscana del Elettricitá lines; and two to Piombino and Massa Maritima respectively, serving the steel works at the former place, and the mines at the latter. The present output is 4,000 kw.

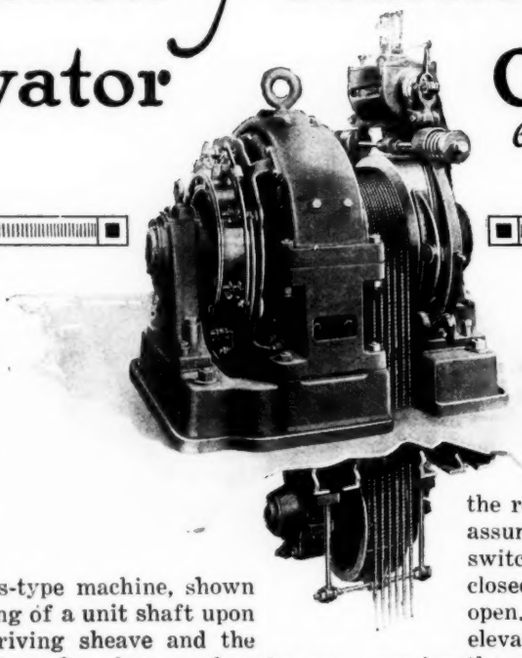
Several important changes are in progress, the exact nature of which is not yet ready for publication. They are under the charge of Signor Plinio Bringhenti, engineer of the Societa Boracifera, who has long been studying and mastering the problems of the plant. This article has been prepared with the invaluable aid of Signor Ugo Funaioli, the director of the electrical department of the Societá.

The Societa Ligure Toscana del Elettricitá depends for the most part upon its hydraulic plants, but as these yearly suffer from lack of water, it has erected at Livorno (Leghorn) a modern steam plant. The reason for the choice was the fact that Leghorn is a port, for the coal used is "Cardiff," imported from England. The coal arrives at the yards in lighters and is stored in piles or transferred directly to the hoppers. The water-tube boilers are uniform, six in number, and have 5,400 sq.ft. of heating surface. Two have chain-grate stokers and two are oil burning.

This company operates the peat plant mentioned in the first part of the article and develops 250 kw., which is used locally, near Lucca. The second plant will be on a larger scale, but will also produce for local consumption.

Operation of Gearless Traction Elevator Controller

by Wm. Zepernick



THE traction-type elevator machine was made necessary by the increased heights of buildings, and this made greater speeds necessary to obtain the proper degree of elevator service. These conditions brought about the development of the gearless-type machine, shown in the headpiece, consisting of a unit shaft upon which a brake wheel, driving sheave and the armature core and winding of a slow-speed motor are mounted. As there is no gear reduction, a slow-speed motor is necessary to obtain a car speed that is not excessive, since a 63.5-r.p.m. motor with a 36-in. driving sheave will develop approximately 600 ft. per min. car travel. It is with the controller for this type of slow-speed gearless-traction elevator motor, as developed and used by the Otis Elevator Co., that this article deals. This type (MFL 4C) controller Fig. 1, and similar types with slight modifications are in extensive use. The principal features of this controller may be outlined as follows:

With the car switch, Fig. 2, six distinct speeds, up and down, are obtainable which are: Direction, fast 1, 2, 3, 4 and 5 respectively. At the terminal landings cams are installed in the hatchway which engage a roller secured to an arm on the stopping switch, Fig. 3, mounted on the hitch beam, on top of the car. Operation of the stopping switch opens a series of contacts which reduce the speed in four steps and then stop the elevator by releasing the direction switch. The setting of the automatic stopping switch on top of the car is such that the speed switches drop out in the reverse order to that in which they pull in. There are seven contacts for each direction on the automatic stopping switch, as shown in the upper left-hand corner, Fig. 4, and the last three contacts, Nos. 5, 6 and 7, open simultaneously. Nos. 5 and 6 each open one side of the direction magnet, and No. 7 opens the circuit which parallels the brake magnet providing for a quick release of the brake at the terminals.

In addition to the circuits controlled by the automatic stopping switch, there are the final limit switches for overtravel at the terminals, the switch in the car for emergency, safety-plank switch under the car, which opens when the safeties are set by action of the governor, and a governor switch for overspeeding. Any of these will release the potential switch, which will open the power line to the machine and brake circuit and apply a hard dynamic brake by means of connecting resistance across the armature.

The wiring diagram, Fig. 4, is an outline of the controller, Fig. 1, looking at the panel from the rear. The contacts are shown in a position assumed with the main switch open. As each switch operates, the contacts shown open are closed and those that are closed immediately open. With all emergency switches closed the elevator may be operated on any speed by moving the car switch to any desired position. The car switch is generally wired so that moving its handle away from the side of the hatch that has the most openings will cause the elevator to run up, the other way for the down direction of travel.

When the main-line switch is closed, as in the wiring diagram, Fig. 4, the shunt-field circuit is immediately energized, which provides a positive field on the motor at the instant of starting. This circuit is from the + to the *D* terminal at the bottom of the controller, through the shunt-field winding on the motor to the *K* terminal on the controller, through the *SFR* resistance to the — terminal on the potential switch *L* and to the — terminal at the bottom of the controller.

After the main-line switch is closed, if all emergency devices such as governor switch, final limits, safety plank switch, emergency switch in the car, etc., are closed, the potential switch will close. All emergency switches with the exception of the last-named are normally closed, since these open only when called upon by overspeeding of the car, overtravel at the terminal landings, etc. The emergency switch is operated at will by the operator and is generally opened when the operator leaves his car.

The top main contacts, M_a, of the potential switch, close to the main-line circuit to the controller. These contacts are equipped with blowout coils to prevent arcing. The auxiliary contacts A_c complete the line to the various operating and brake circuits. The bottom main contacts M_b are utilized to connect the section of bypass resistance between E' and i across the armature to insure a quick stop should the potential switch be released when the elevator is in motion. The lower auxiliary contacts A_l are used to short-circuit the resistance in series with the closing coil *L*. The purpose of this connection is to insure a strong pull when closing the switch from the off position. After the switch pulls in, these contacts open and cut resistance

in series with the magnet coil and reduce the current.

An overload magnet, O_m is sometimes used, is connected in series with one feed wire and is utilized to actuate a contact in series with the potential switch should the current exceed a predetermined amount.

A small single-pole double-throw knife switch S_p is shown on the left of the potential switch. With the single-pole switch thrown to the down position, the potential switch will not close automatically when the line switch is closed and the controller made alive, but will remain closed after it has been closed by hand provided all emergency switches are closed. With the single-pole switch in the up position, as in the Fig. 4, the potential switch will close automatically when power is on the board, provided all emergency switches are closed. General practice provides for the potential switch to be self-closing. The circuit for closing coil L on the potential switch is from its top main contact marked + through the switch S_p and the small fuse to L terminal at the top of the board, then into the conduit C_r and through the L and + L contacts on the car-governor switch. From the governor the circuit returns to the top of the board and goes into the C_r conduit and up through the counterweight-governor switch, when used, and one set of contacts on the limit switch at the top of the hatchway, then to + L'' on the bottom limit switch through the slack-cable switch, when used, on the compensating sleeve, back to the + P terminal on the controller, down through the ARP resistance and

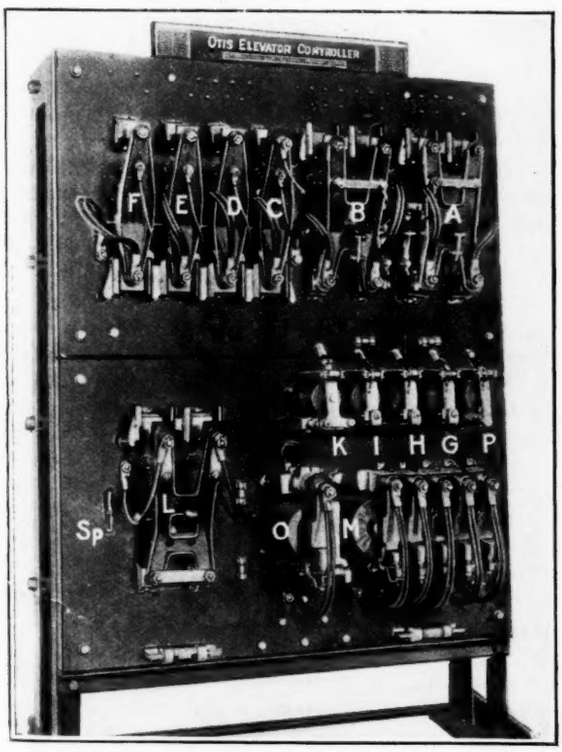


FIG. 1—FRONT VIEW OF OTIS TYPE MLF4C CONTROLLER FOR GEARLESS TRACTION ELEVATOR MACHINES

its short-circuiting contacts A_1, through coil L and the contacts on overload relay O_m to —P at the top of the board. From the top of the board the circuit again goes to the top hatchway limit switch and through contacts —P and —L', then through contacts —L' and —L on the bottom hatchway limit switch to the —L terminal on the safety switch in the car. From the Y terminal on the safety switch in the car the circuit goes to the switch mounted on the safety plank under the car and from here to the Y' terminal on the board, then through a fuse and to the G' and —$'$ contacts on the car-governor switch, and returns to the —$'$ terminal on the board and the — top contact of the potential switch, thus completing the circuit, as indicated by the arrowheads. This will cause the potential switch to close and complete the power circuit to the controller. A simplified

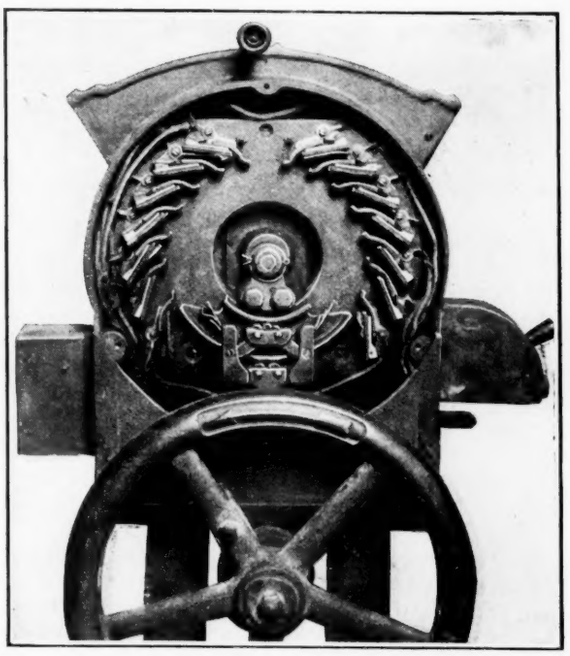


FIG. 2—CAR SWITCH WITH COVER REMOVED

diagram of the potential switch circuit is shown in Fig. 5.

The operation of the control will be considered under the following conditions: Throwing the car switch completely over to full-speed position up and stopping automatically at the top terminal landing. Any other condition of operation will merely change the time rate of acceleration and stopping, with the exception of the brake operation, which will be explained for the condition of lifting full load to the top terminal landing.

With the car-switch handle moved to full-speed up position, the circuit is completed for the up-direction switch B on the board, and it closes. This circuit is from the M_a contact on the + side of the potential switch through the heavy line to tap X on the left-hand side of the board. From tap X the circuit is through the fuse, $AR4$ resistance to terminal SL' and through the shaft-door contacts, back to SL terminal on the board, then to between No. 5 contacts on the stopping switch mounted on top of the car. From $+U$ on the stopping switch the circuit returns to $+U$ on the controller, through closing coil B on the up-direction switch, N_r contacts on the non-reversing magnet G, to U' terminal at the top of the board. The circuit now goes to U' on No. 6 contacts of the stopping switch and to U and C on the car switch, then to C and O—— on the safety switch back to O— on the board, down through a fuse and the right-hand auxiliary contacts A_c on the potential switch to the — side of the line, thus causing the up-direction switch to close.

The up-direction switch pulling in, closes the contacts

shown open and opens those shown closed in Fig. 4. The up- and down-direction switches are mechanically interlocked so that the action of one direction switch when pulling in, causes the other switch to drop back to the extreme position open, so that the bottom contacts will close. These switches are so interlocked to prevent the bottom contacts on both switches closing

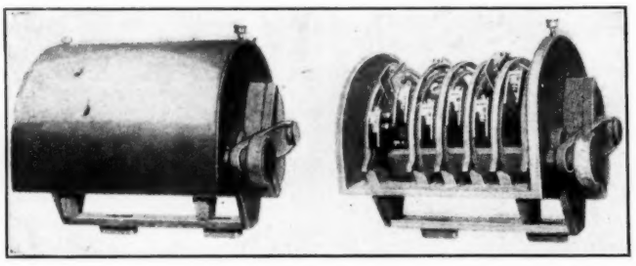


FIG. 3—STOPPING SWITCH LOCATED ON TOP OF CAR

at the same time, for should this happen, the armature would be short-circuited through these, causing a very severe stop. Closing the up-direction switch completes the circuit to the motor's armature, from the M_a terminal on the + side of the potential switch through 2 and 4, and 1 and 3 contacts in parallel on the up-direction switch, to the left and down through the right-hand bottom contact of down-direction switch, which is closed when the up-direction switch closes. Then the circuit is through hold-down coil of down-direction switch to *I* through the armature and back to *E*, on the boards through the minimum starting resistance and line marked 2 and 3, back through the left-hand bottom contact on down switch to *SB* terminal, through the series winding of the brake back to *SB'* through the closed contact of auxiliary brake magnet *O*, to *R* on the maximum starting resistance to 9, through right-hand M_a contact of the potential switch, through the overload magnet to the negative side of the line.

Releasing of the Brake

The auxiliary making contacts, R_a, on the up-direction switch *B*, when closed, complete the circuit to the shunt winding of the brake from the + side of the line through the main contact on potential switch *L* through the left-hand auxiliary contact A_c through the up-direction switch auxiliary contacts R_a, *BR* resistance and to +*B* terminal, then through the shunt coil of the brake magnet back through —*B* line and small fuse, through the other auxiliary contact A_c on the potential switch to the — side of the line. The brake magnet then releases the brake shoes from the pulley and allows the motor to start on slow speed.

The initial lift of the brake is obtained by the combined action of the shunt and series winding. The action of the brake lifting closes the contact B_c mounted upon it, which provides a circuit through the auxiliary brake magnet *O* on the controller, from the bottom contacts R_a on the up-direction switch, through the *ABM* resistance, coil *O* and to the —*B'* terminal and to the B_c contacts on the brake back to the —*B* terminal on the board and to the — side of the line. The auxiliary brake magnet *O* closes, which first short-circuits the series winding of the brake and then open-circuits the line leading to this winding. This eliminates any sneak current through the series winding due to poor short-circuiting contact. A sneak current through the series winding of the brake would change the character of its action and should be avoided.

It has been shown that the armature is in series with the minimum and maximum starting resistance and the series winding of the brake at starting, the series winding of the brake being short-circuited by the *O* magnet after the brake has lifted. In addition to this circuit there is a bypass circuit across the armature to obtain a positive slow speed which could not be obtained otherwise, as load conditions would greatly vary the low speed with the starting resistance in series with the armature.

Bypass Armature to Obtain Slow Speed

This bybass circuit is from a tap *I'* just below and between the direction magnets then to the *I* terminal on the bypass resistance, through this resistance to 4', through the bottom contact of the fast-speed magnet 4' (*C*), through the blowout coils of fast-speed magnets *C*, *D*, *E* and *F* to *E* lead of the armature. From here the circuit is completed to the — side of the line as explained for the armature.

The fast- and slow-speed magnet *K* operates immediately upon either direction switch pulling in. It is connected in series with resistance, which is mentioned here particularly because the resistance is utilized for other means than for reducing current value (see Fig. 6). The contact which *K* operates short-circuits the shunt-field resistance of the motor. The final point in the car-switch completes a short-circuit across this magnet, causing it to release, cutting in the shunt-field resistance and getting final high speed of the motor. This cannot be done, however, until after the accelerating magnet *M* contacts pull in and the auxiliary contact M_c on the last arm of the accelerating switch has closed. The circuit for the fast-and-slow speed magnet *K* is from a tap F_s just below contact 4 on the down-direction switch, down through the *AR*3 and *AR*3' resistances, coil *K* to the — side of the potential switch. The closing magnet *K* short-circuits the *SFR* resistance in the shunt-field circuit, providing full field on the motor during the period of starting. The conditions so far described are those that would obtain if the car switch closed contacts *U* and *C*, which would give the slowest operating speed. With the car switch in the full on position a number of other operations take place to bring the motor up to full speed. The second, third, fourth and fifth operations in accelerating the motor are the closing of the fast-speed magnet switches *C*, *D*, *E* and *F*.

Operation of Fast-Speed Switches

The first fast-speed switch to close is *F*, and the circuit for its coil is from the auxiliary contact R_a on the up-direction switch, through coil *F* and *AR*13 resistance to terminal *F*1 at the top of the board, and to between No. 4 contacts on the stopping switch, to *F*1*U* contact and to *F*1*U* on the car switch and to the negative side of the line, as previously explained.

Fast-speed switch *F*, upon closing, cuts in the portion of the bypass resistance between 1' and 2' by opening its lower contact. The top main contact, closing, short-circuits the portion of minimum starting resistance between *E* and 1. The auxiliary contact F_f completes the circuit for fast-speed magnet *E*.

It should be noted that lower contacts 1', 2' and 3' on the fast-speed magnets connect to 1', 2' and 3' respectively on the bypass resistance, also top contacts 1, 2 and 3 connect to terminals 1, 2 and 3 respectively on the minimum starting resistance, although the connections are not shown.

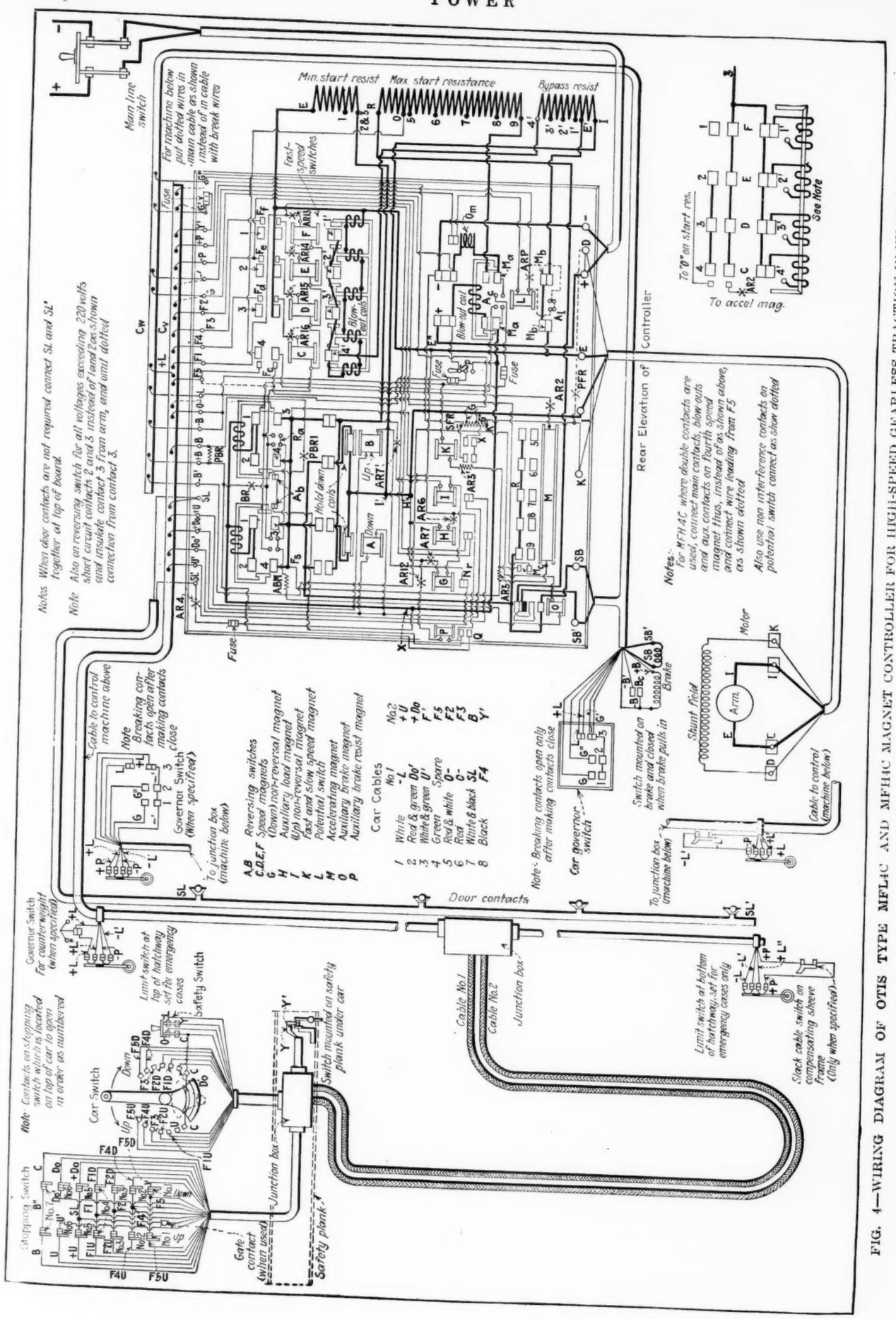

Min. start resist
Max. start resistance
Bypass resist
Main line switch
Fuse
Controller
Rear Elevation of
To accel mag.
To "0" on start res.
See Note
Notes:- For MFH 4C where double contacts are used, connect main contacts, blow outs and aux. contacts on fourth speed magnet thus, instead of as shown above, and connect wire leading from F5 as shown dotted
Also use non interference contacts on potential switch connect as show dotted
Car Cables
No. 1 White -L
2 Red & green Do'
3 White & green U'
4 Green Spare
5 Red & white O-
6 Red
7 White & black SL
8 Black F4
A,B Reversing switches
C,D,E,F Speed magnets (Down) non-reversal magnet
G Auxiliary load magnet (Up) non-reversal magnet
H Fast and slow speed magnet
I Potential switch
K Accelerating magnet
L Auxiliary brake magnet
M Auxiliary brake resist magnet
No. 2 +U
+Do
F'
F5
F2
F3
B'
Y'
Note Breaking contacts open after making contacts close
Governor Switch (When specified)
To Junction Box (machine below)
Cable to control machine above
Door contacts
Car governor switch
Note: Breaking contacts open only after making contacts close
Switch mounted on brake and closed when brake pulls in
Brake
Shunt field
Arm
Motor
Cable to control (machine below)
To junction box (machine below)
Governor Switch For counter weight (when specified)
Limit switch at top of hatchway set for emergency cases
Safety Switch
Car Switch
Down
Up
Stopping Switch
Gate contact (when used)
Safety plank
Switch mounted on safety plank under car
Cable No. 1
Cable No. 2
Junction box
Limit switch at bottom of hatchway set for emergency cases only
Stack cable switch on compensating sheave frame (Only when specified)
Note Contacts on stopping switch which is located on top of car to open in order as numbered
Notes When door contacts are not required connect SL and SL' together at top of board
Note Also on reversing switch for all voltages exceeding 220 volts short circuit contacts 2 and 5 instead of 1 and 2 as shown and insulate contact 3 from arm, and omit dotted connection from contact 3.
For machine below put dotted wires in main cable as shown instead of in cable with break wires

FIG. 4—WIRING DIAGRAM OF OTIS TYPE MFL4C AND MFH4C MAGNET CONTROLLER FOR HIGH-SPEED GEARLESS TRACTION ELEVATOR MACHINES

A circuit to close the second fast-speed magnet switch E is obtained from the + line as for F, through coil E, resistance $AR14$, auxiliary contact F_f on F, to the $F2$ terminal on the board. From here the circuit is to between No. 3 contacts on the stopping switch to contact $F2U$ on the car switch and returns to the negative side of the line as previously explained. Energizing coil E causes contacts 2 to close and 2′ to open. Closing contacts 2 short-circuits the remainder of the minimum starting resistance, and opening contacts 2′ cuts in the portion of the bypass resistance between 2′ and 3′, thus increasing the speed of the motor. Closing auxiliary contacts F_e completes the circuit for fast-speed magnet coil D, which is the fourth step in accelerating the motor. A circuit is obtained for coil D from the same line as E, through D, resistance $AR15$, auxiliary contacts F_e to $F3$ terminal on the board and then directly to the $F3$ contact on the car switch and to the negative side of the line.

It will be noticed that the circuit for D magnet coil does not pass through the stopping switch, but goes directly to the car switch. As this circuit is utilized when the motor is under load at the terminal landings, it will be further considered when the stopping at the terminal is discussed. The top main contact of D switch short-circuits the minimum starting resistance in the same manner as E switch; in fact, the contacts are paralleled. The bottom main contact inserts bypass resistance between 3′ and 4′, and auxiliary contact F_d completes the circuit to fast-speed magnet C.

Closing magnet coil C is the fifth step in starting the motor. A circuit for this magnet coil is from the same + line as for D, through coil C, resistance $AR16$, to terminal $F4$ and to between the No. 2 contacts on the stopping switch, then to $F4U$ on the car switch and returns to the negative side of the line. Closing switch C opens contacts 4′, which open-circuits the bypass resistance. Closing contacts 4 closes the circuit to the accelerating magnet M at the bottom of the board and closing auxiliary contacts F_c provides a circuit to be completed for the final speed only after the accelerating

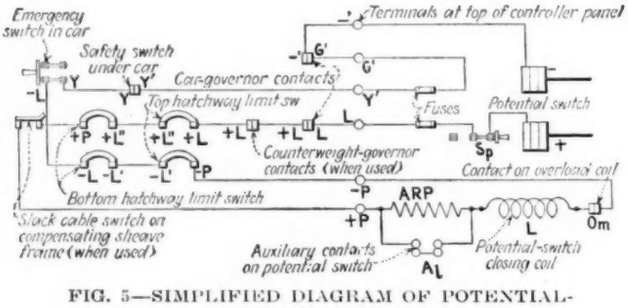


FIG. 5—SIMPLIFIED DIAGRAM OF POTENTIAL-SWITCH CIRCUIT

magnet M has closed all its contacts. The operation of the accelerating magnet which then follows is entirely automatic upon the closing of C magnet.

One side of the accelerating magnet is connected to the top main contacts of the direction switches at F_s where it obtains positive line, and the circuit continues through the accelerating magnet coil M through $AR2$ resistance, then through top contact 4 of fast-speed magnet switch C to point O in the starting resistance, the latter being connected to the negative line of the main circuit and to the armature, so that the circuit is completed from O to 9 and to the — side of the line. This connection provides for any degree of acceleration desired between the minimum and maximum time required for the accelerating magnet to close its five contacts 5, 6, 7, 8 and 9. By shifting O closer to R the accelerating magnet connection is brought closer to the armature; that is, the voltage across coil M is more dependable upon the speed at which the armature rotates. The speed of the armature is approximately a measure of the voltage drop across its terminals,

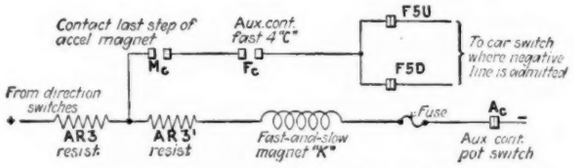


FIG. 6—SIMPLIFIED DIAGRAM OF SHUNT-FIELD RESISTANCE MAGNET CIRCUIT

and when the accelerating magnet is connected across the armature terminals, the strength of magnet M will increase as the speed of the motor. Shifting connection O towards 9 increases the voltage drop across M, making it more independent of the speed of the armature until when O is connected at point 9, full line voltage is obtained across the accelerating magnet circuit, when magnet M will pull in its contacts rapidly and entirely independent of the motor acceleration.

The accelerating magnet M, upon operating, closes its five contacts in sequence, each short-circuiting a portion of the maximum starting resistance. It is to be noted that contacts 5, 6, 7, 8 and 9 on M connect two points, 5, 6, 7, 8 and 9 respectively on the maximum starting resistance. Contact No. 5 is the first to close and No. 9 the last.

Connecting Resistance in Field Circuit

The last contact arm of the accelerating switch closes an auxiliary contact M_c in addition to the one which short-circuits the last portion of starting resistance, and this auxiliary contact provides for releasing the fast- and slow-speed magnet K. It was shown that K magnet obtained positive line from contacts on the direction switch, through $AR3$ and $AR3'$ resistances through K coil, small fuse, auxiliary contact on potential switch and to negative line. To release this magnet, negative line passes from C to $F5U$ contact finger in the car switch, to $F5U$ lead on No. 1 contact in the stopping switch to $F5$ on the controller, through auxiliary contact F_c on fast-speed magnet C, auxiliary contact M_c on the last arm of M, to a point between $AR3$ and $AR3'$ resistance in the K magnet circuit. Under this condition the negative side of the line is connected to both sides of K coil and is equivalent to short-circuiting this coil and causes it to release its contactor (see Fig. 6). The contacts on K magnet open the short-circuit across the SFR (shunt-field resistance), Fig. 4, which weakens the field and obtains the last and final speed of the motor.

The elevator is then running at full speed, and should there be a tendency to overspeed because of light load up or full-load down, the governor closes contact G, which short-circuits a portion of the SFR resistance, between — and G, to maintain a speed within definite limits. If this does not maintain the speed within a predetermined limit, contacts G'' on the governor switch close and short-circuit another section of the SFR resistance between G and G''. Attention is called again to the fact that the wiring diagram shows the position

of the switches from the rear of the control panel, therefore switches are shown reversed to what these would appear facing the panel.

Stopping at Terminal Landing

Upon approaching the terminal landing, the contacts in the stopping switch, Fig. 4, open in the following order:

No. 1 opens and causes *K* switch to close by removing the short-circuit from across its coil, and again short-circuits the *SFR* field resistance, increasing the field strength and slowing down the motor.

No. 2 opens and causes fast-speed switch *C* to release and open its top main contact, thus opening the circuit

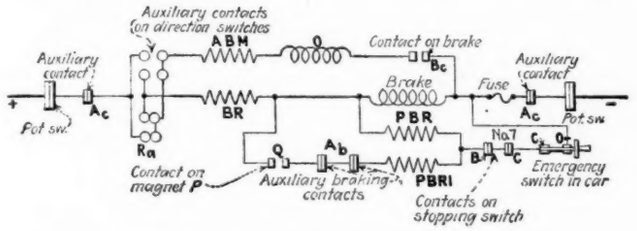


FIG. 7—SIMPLIFIED DIAGRAM OF BRAKE CIRCUIT

to the accelerating magnet, which, releasing, cuts the maximum starting resistance in series with the armature. The bottom main contacts of *C*, closing, connect the bypass resistance across the armature.

No. 3 opens and causes fast-speed switch *E* to release, which closes its bottom contacts and short-circuits a portion of the bypass resistance 2′ and 4′. The top main contacts open, but do not remove the short-circuit on a portion of the minimum starting resistance, since these contacts are in parallel with the top main contacts on switch *D*. Opening of the auxiliary contacts on switch *E* releases switch *D*. When the fast-speed switch *D* releases, opening its top main contacts removes the short-circuit from the section of minimum starting resistance between 1, 2 and 3. Closing the bottom contacts of *D* does not have any effect since the section of bypass resistance between 2′ and 4′ has already been short-circuited by switch *E* closing contacts 2′, therefore the only effective operation has been to open the short-circuit across the terminals of the minimum starting resistance.

No. 4 on the stopping switch opens the circuit through fast-speed switch *F*, which releases and opens its top contacts and removes the short-circuit across the section of minimum starting resistance from *E* to 1. The bottom main contact short-circuited the portion of bypass resistance between 1′ and *E*′. The elevator will now run at its minimum speed with all starting resistance in series with the armature and the minimum amount of bypass resistance across the armature terminals.

Should the load be heavy, the motor might be unable to raise it to the top landing with all resistance in series and the minimum amount of bypass across the armature. Should such be the case the auxiliary load magnet *H*, which is connected across the armature leads from *H*′ on the *I* lead through coil *H* and the *AR*6 resistance to *E*″ on the *E* lead, is so adjusted that if the armature slows down greatly, *H* magnet releases. The reason for this was outlined where it was explained that the voltage across the armature terminals was approximately a measure of its speed. *H* magnet, releasing, closes its contacts, which permits *F* magnet to close again and short-circuit a portion of the minimum starting resistance and cuts in that part of the bypass resistance between 1′ and 2′, increasing the voltage drop across the armature and giving a greater torque for the motor to raise the full load to the top-floor landing. It might be said that this should be unnecessary, as the resistance could be adjusted to eliminate this operation, which is so, but for true refinement of control and uniformity of slow-down at terminal landings with and without load this method is used.

The circuit for fast-speed magnet coil *F* is from the + side of the potential switch through coil *F* and *AR*13 resistance as before, but instead of the circuit going to *F*, it is now through the contacts on *H* and back to *F*3 terminal at the top of the board and to the *F*3 contact on the car switch to *C* contact and returns to the — side of the line.

Nos. 5, 6 and 7 contacts on the stopping switch open simultaneously. Nos. 5 and 6 each open one side of direction-switch magnet. No. 7 contact opens the parallel or discharge resistance *PBR* across the brake magnet. This provides for a quick positive stop at the terminals. The direction switch, releasing, disconnects the armature and brake from the line, at the same time releasing *K* magnet, which opens its contacts and inserts the *SFR* resistance in the shunt field.

Preventing Overtravel at Terminal Landings

Should the car overtravel the terminal landings, then either the top or bottom shaft-limit switches will be opened by the car, which will release the potential switch. When the top contacts of this switch open, power is cut off from the controller, and the auxiliary contacts A_a opening, open the brake and operating circuits. The bottom contacts of the potential switch, closing, connect the section of the bypass resistance between *E*′ and *I* across the armature, and would result in a strong dynamic braking action to stop the elevator as long as the armature was in motion.

The down non-reversing magnet on switch *G* is so connected that only when the down-direction switch *A* is closed, coil *G* is connected across the armature. The contact opens the circuit to the up-direction switch and prevents reverse travel until the armature has practically come to rest.

The up non-reversing magnet *I* is connected so that only when the up-direction switch *B* is closed, coil *I* is connected across the armature. The function of this magnet is similar to *G*, but used for the opposite direction of travel.

There are two parallel circuits across the shunt winding of the brakes. One of these circuits *PBR* is of high resistance, the other is of low-resistance *PBR*1. At the terminal landings these parallel circuits are disconnected by means of the stopping switch on the top of the car. This circuit is opened by contact No. 7 in the stopping switch, one contact provided for each direction of travel. A simplified diagram of the brake circuits is shown in Fig. 7. The high resistance circuit *PBR* can be disconnected only during regular operation by the stopping switch. The low-resistance circuit *PBR*1 is taken through the auxiliary contacts A_b on the direction switches and contact *Q* on the auxiliary brake-resistance magnet *P*. Since the auxiliary brake-resistance magnet is connected across the armature, contact *Q* is closed only when traveling at high speeds; then when the car-switch handle is centered, the auxiliary contacts A_b on the direction switches will close before the

elevator comes to rest. This permits the brake magnet to discharge through both parallel circuits, when stopping from high speed.

When stopping from low speed, such as inching or a short run, the auxiliary brake-resistance magnet will not close its contact. Therefore, the brake magnet can discharge through the high resistance *PBR* only, thus insuring quick brake application.

Governor Prevents Overspeed

The governor is equipped with two making and two breaking contacts and in this particular case will have four settings, all of which will be overspeed travel. The first setting closes a contact *G* which short-circuits a portion of shunt-field resistance between — and *G*, which should check the speed of travel. Should this not be effective, the second making contact *G″* short-circuits an additional portion of shunt-field resistance, giving a further check to the speed of travel. Such conditions as overload, falling elevator, open shunt field, poor connections at definite places would prevent the governor making contacts *G* and *G″* from producing the desired results, in which case the third setting, contacts *G′* and *L*, provide for the opening of the potential switch magnet. When the potential switch releases, it provides a hard dynamic stop for the elevator motor, disconnecting the line from the equipment and opening the brake circuit. The fourth setting of the governor provides for applying the car safeties. This action is rarely obtained, as the condition which should call for it is only when the elevator car is mechanically disconnected from the elevator machine, which will be only when the hoisting ropes have broken.

It must be remembered that the controller described in the foregoing is one for a definite purpose and that this description appertains to this control only. The reader by a little study can understand any control of a similar nature, as the general principles are similar.

The Advisability of Supplementing a CO_2 Recorder with an Occasional Orsat Analysis

By A. R. Mumford

On a recent test of a bank of two 8,400-sq.ft. water-tube boilers the total flue-gas losses were reduced from 33 per cent at the beginning of the test to 13 per cent for the remainder of the test by changing the air supply. The necessity for this change was indicated by a determination of the O_2 and CO in the flue gases by means of a water Orsat.

The plant on which the test was made was completely equipped with indicating and recording instruments, so that the only unknown items were the constituents of the flue gases remaining after the CO_2 was removed. Complete and regular records were kept and close attention was given to the improvements possible in the operating efficiency. Thus the plant was in excellent condition from an operating viewpoint, and only the unknown presence of CO in the flue gases was working against the greatest economy.

For the purposes of the test several thermocouples were inserted through the walls of the boiler, primarily to determine the temperature of the gases in the different passes for comparison of two arrangements of baffles, and an extension put on the flue-gas sampling pipe already installed for a CO_2 recorder. To this extension a water Orsat was connected and samples were collected over twenty-minute periods for the duration of the test. Thus the Orsat samples were of the same composition as those analyzed by the recorder and served as a check on the recording instrument. The recorder indicated 13.5 per cent CO_2 in the flue gases, and at that time, as in all subsequent analyses, the Orsat and the recorder were in complete agreement, showing that the recording instrument was operating satisfactorily.

On the completion of the first Orsat analysis, however, it was shown that the total flue-gas loss was approximately one-third of the heat in the coal fired because of the presence of 4.2 per cent of CO and the unburnt hydrocarbons and hydrogen in the flue gases The operating engineer without the Orsat reading to direct him would have had no indication of this loss immediately, and if he had been anxious to increase the CO_2 content of the flue gases he would have decreased the air supply at a time when the opposite was necessary to eliminate the CO and to increase the CO_2. After a second twenty-minute sample showed that the bad conditions were not momentary, the air supply to the stokers was increased until the CO in the flue gases was reduced to one-half of one per cent or less, and the total flue-gas losses were reduced to 13 per cent. The elimination of the CO loss was accompanied by an increase of 2.5 in the percentage of CO_2, which for the remainder of the test was steady between 15 and 16 per cent. At the same time the excess air increased from 2 to 8 per cent.

The increased air supply resulted in a saving of 60 lb. of coal a minute at the rate of combustion in use during the test. This loss would undoubtedly have continued for some hours and perhaps longer before the attention of the engineer would have been attracted and before the reason could have been ascertained from the instruments installed, although the readings of all instruments were found to be accurate by checking. The existence of such a loss is shown ordinarily by a correlation of the reading of a number of instruments, and the time elapsing before the several readings could be correlated would permit a loss of such magnitude that the fuel cost per kilowatt-hour would become excessive. Assuming that such a loss existed for five hours, the coal lost would be 10 tons, which at $5 a ton would be equal to the cost of an ordinary water Orsat.

A CO_2 recorder could be supplemented by an Orsat using the same piping at negligible additional expense. The average fireman, after his fear of delicate glassware and mysterious chemicals are overcome, will find that the operation of a water Orsat is extremely simple. The insurance provided by the occasional checking with such an apparatus is sufficient to justify its purchase and use, and the possibility that a preventable fuel loss of 20 per cent may exist for some hours before discovery without the check provided by an Orsat, greatly enhances its value.

Wire rope must not be handled like hemp rope, and kinks or near kinks must be strictly avoided. In installing ropes that come in coils, the rope should be stretched full length on the ground by unrolling the coil like a wheel. Before cutting a cable, it must be tightly bound with a number of turns of iron binding wire on each side of the proposed cut, to avoid the "unlaying" of the strands and the attendant "high strands" while in operation.

Does an Engine Bearing Need a Cap?

A Discussion of the Load and Pressure Force in the Main Bearing of Horizontal Engines

By FRED WILLIAM BOSCH, M.E.

FROM discussions appearing in technical publications it seems that the direction of pressure on an engine bearing is not well understood. The pressure forces in engine bearings are manifold in kind and do not depend alone on the dimensions of bearings, etc., and the pressure to which the walls are subjected, but also on the "play" of the shaft, flywheel, rotor or crank, however imperceptible these may be. Additional factors are shifting of a bed not held absolutely rigid on the foundation, water hammer in the cylinders, excessive friction caused by heating of the piston rod, bearings, etc.

Forces Causing Engine Stresses

Every engine should be so designed and proportioned that the strength of the various parts will not be seriously impaired even after years of service when naturally the parts have worn to some extent, causing a certain looseness or play to be present. Since it is impossible to determine these pressure forces accurately by calculation, we are compelled to examine the individual parts as to strength and stress when subjected to the known theoretical pressures, and as such pressures we have: (a) The load or force in the main

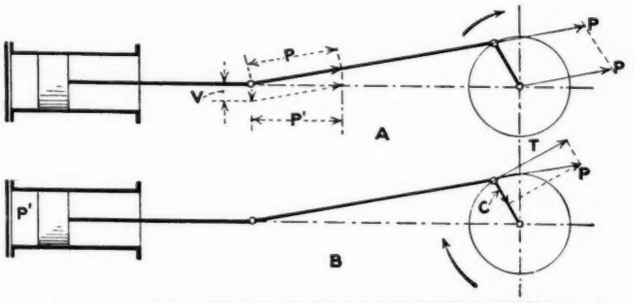


FIG. 1—FORCE ACTING ALONG THE CONNECTING ROD

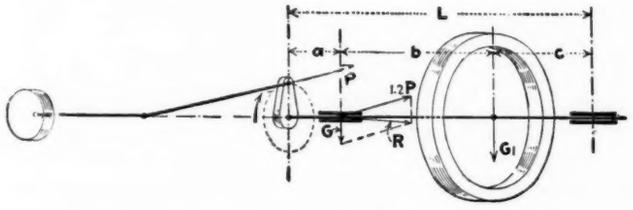


FIG. 2—EFFECT OF FLYWHEEL WEIGHT ON BEARING PRESSURE

reciprocating parts; (b) load or pressure in the main bearings; (c) load or pressure in the valve gear.

Many parts, such as engine beds, can be examined as to strength only in certain places, and it is hardly possible to determine the shearing stress on the foundation bolts, because the applying forces are of a complicated nature. The usual and safest procedure in such cases is to use and abide by dimensions that are the result of time and experience.

The main bearing is one of the most important parts of a steam engine, and it is essential that one have an absolute clear conception of the occurring forces in the bearing, and such understanding is best acquired by means of working out an example.

Assume that the bearing pressures of a single-cylinder engine are to be investigated for the different

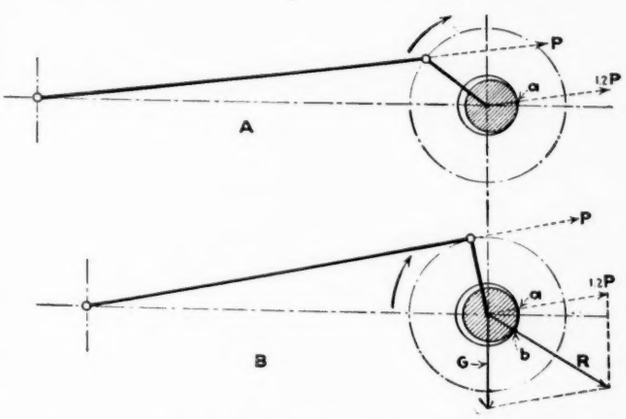


FIG. 3—DIRECTION OF PRESSURE ON MAIN BEARING

crank positions, and that it is desirable to know in what crank position the greatest bearing load or pressure occurs and its direction of pressure. In addition it will be found whether the engine can operate with the main-bearing cap removed.

In calculations of this kind it should be borne in mind that the influence of the flywheel, rotor and crankshaft weights are of considerable moment and must not be neglected, for deductions arrived at without considering them are of no practical value.

Force Diagrams

First we will draw up the general force diagram of the engine as shown in Figs. 1*A* and 1*B*, without considering the length of the crankshaft and the flywheel weight. In these diagrams P' is the total piston pressure, P the pressure force occurring in the connecting rod and V the pressure on the crosshead guide acting vertically downward. Since the value of V is small, for practical work the connecting-rod force P' may be assumed to be equal approximately to the corresponding piston pressure, therefore we will set $P = P'$, the total pressure exerted on the piston by the steam.

The force P along the connecting rod resolves itself in two components, one being the tangential force T which acts to turn the crank, and the other one the centripetal force C acting along the crank arm as shown in Fig. 1*B*.

The values of these forces may now be readily determined if the piston pressure P' of the corresponding crank position is known. If the main bearing was situated in the same plane as that of the crankpin, the

load or pressure on the main bearing would exactly equal that on the crankpin in value as well as in direction. In reality the main bearing is situated at a distance a, Fig. 2, from the crankpin, and it becomes necessary to find the value of the main-bearing pressure due to the connecting-rod thrust.

If X is the main-bearing pressure in the same direction as, and due to that of, the connecting rod force, this pressure acting upon a lever arm $b + c$ having its fulcrum at the center of the outboard bearing just balances the piston pressure P acting upon a lever arm equal to L. By taking moments we have

Moment (right) $M_r = PL$

Moment (left) $M_l = X(b + c)$

Therefore the load or pressure on the main bearing becomes

$$X = \frac{PL}{b + c} = P\left(\frac{L}{b + c}\right)$$

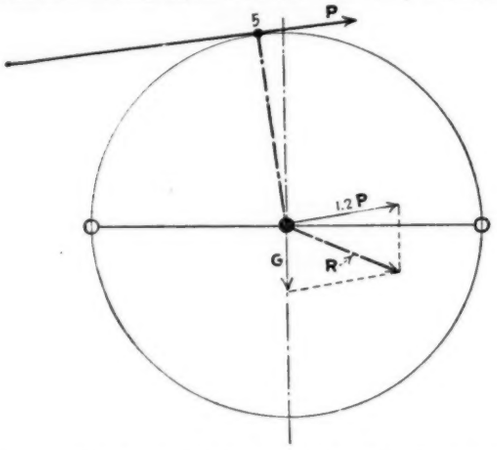


FIG. 4—METHOD OF FINDING THE RESULTANT OF PISTON PRESSURE AND FLYWHEEL WEIGHT

Taking an average of normal installations, we find that the value $\frac{L}{b + c}$ is 1.2. This, then, gives a general average for the bearing pressure X of $1.2P$, as is indicated in Fig. 2. The pressure or load and its direction in the main bearing changes with every piston or crank position; it is greatest during the admission period and diminishes during the expansion period.

The weight G_1 of the flywheel acts vertically downward; that is, it presses the shaft down on the lower bearing box. Taking moments we have

$$M_l = G_1 c; \text{ and } M_r = G(b + c)$$

therefore the vertical pressure or the load on the main bearing due to the flywheel weight is $G = \frac{G_1 c}{b + c}$

From observation of numerous installations it has been found that an average value of G is $0.5G_1$. Therefore, when P is the direction and value of the connecting-rod force, the direction and value of the pressure in the main bearing without a flywheel, Fig. 3A, is $1.2P$, and if a is the theoretical point where the bearing touches the box by reason of P, R, Fig. 3B, is the value and direction of resultant of P and G, and b is the point where the bearing touches the box, when the flywheel is considered.

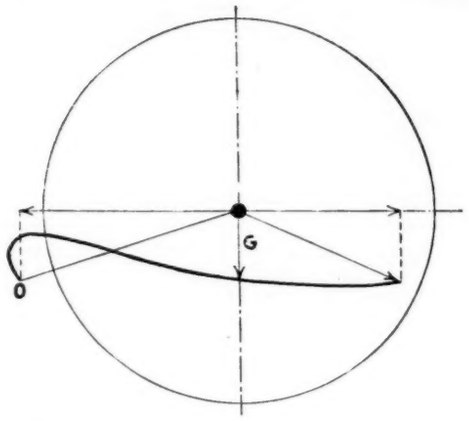


FIG. 5—DIRECTION AND INTENSITY OF THE BEARING PRESSURE ON THE CRANK-END STROKE

As will be noted, the effect of the flywheel is to move the point or surface of contact downward a little, because the flywheel weight always presses in a downward direction.

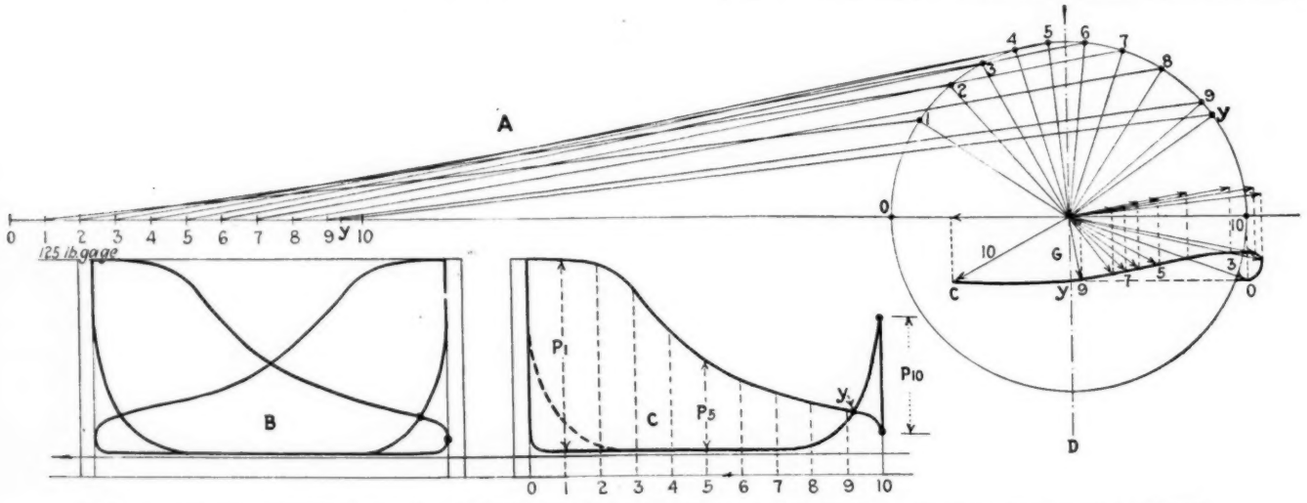


FIG. 6—FINDING DIRECTION AND INTENSITY OF THE BEARING PRESSURE DURING THE PISTON STRIKE

We will now, for the purpose of illustration and clear understanding, work out a definite example and choose a non-condensing engine of the following dimensions: Cylinder diameter, $D = 22\frac{1}{2}$ in.; effective piston area, $F = 388$ sq.in.; stroke, $S = 36$ in.; steam pressure, $P = 125$ lb. per sq.in.; flywheel weight, $G_1 = 27{,}000$ lb.

In order not to confuse the procedure and complicate

the picture with the "acceleration pressure curve," we will neglect the influence of the kinetic energy of the reciprocating parts. In reference to this it may be stated that its effect changes the result to a marked degree only in high-speed engines.

First, the indicator diagram of the head and crank ends for normal load, Fig. 6*B*, is laid out and from these is developed the effective-pressure diagram shown at *C*. This diagram shows the net pressure acting on the piston face in pounds per square inch, and it is necessary to find the total pressure resultant acting on the bearing at each of these piston positions. This has been done in Fig. 6*A*, where the crank circle, connecting rod and piston stroke have been laid out to scale, giving the crank positions, 1, 2, 3, etc., for corresponding piston positions. The flywheel pressure *G* acts downward and the resultant bearing pressure is obtained by drawing, say for position 5, a line from the crank center and parallel with the connecting rod and of a length proportional to the rod thrust *P*. The resultant *R* is found by the force diagram as shown in Fig. 4. The same process is followed for the several piston positions and the resultants for the several positions of the crank jointed by the heavy line *OC'*, Fig. 6*A*, showing the intensity and direction of the pressure on the bearing for the forward stroke.

In Fig. 5 there is shown the corresponding resultant pressure curve for the return stroke but to a somewhat larger scale. The greatest bearing pressure, as is evidenced by Figs. 6*A* and 5, occurs at dead center, that is, at the beginning of the stroke. The smallest bearing pressure we find in the crank position *y*, this point being indicated in Figs. 6*A* and *C*, and it occurs at the point where the direction of the effective pressure on the piston changes. At this point we find the flywheel weight exerts a vertical downward pressure of $G = 0.54$ in. $\times$ 25,000 = 13,500 lb.

Bearing Cap Receives No Pressure

In conclusion it is noticed from this discussion that ordinarily the direction of all forces and pressures is below the horizontal axis—that is, in the lower half of the bearing circle—clearly indicating that the bearing cap receives no pressure at all and therefore the engine should be able to operate with the bearing cap removed, as far as actual pressure in the bearing cap is concerned. The custom of many engine builders to omit the top bearing box of the main and outer bearing therefore is fully justified.

It is customary to determine the resultant pressure *R* correctly only when accurate calculation is required or desired or for large engines with heavy flywheels, but for ordinary cases it will be found quite safe and satisfactory to use the approximation value for *R*. There are other factors that may enter and could be considered, but their influence does not appreciably alter the result; for instance, in cases of belt drive the effect of belt pull is but negligible and may be disregarded in the calculation of bearing sizes.

The Kingsbury thrust bearings carry a number of bearing pads which are self-aligning. The moving pads take a slanting position with regard to the flat surface against which they rub. This allows the lubricant to be carried under them in the most favorable condition and permits much more stress to be safely supported than is possible when parallel flat collars rub against each other.

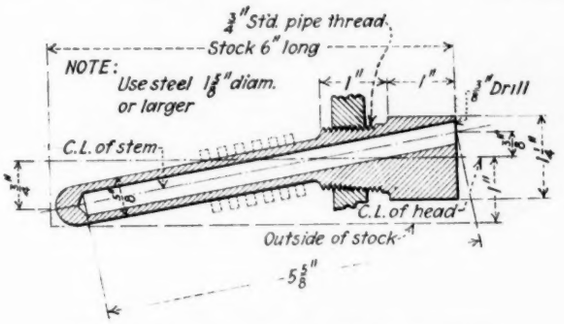
A Thermometer Well for Use in Vertical Pipes

By C. Harold Berry*

The ordinary thermometer well cannot be used in vertical pipes because the filling material, being liquid, will run out. Also, if there is any vibration, the thermometer itself will be in danger of jarring out and breaking. It is hardly possible to incline an ordinary well in a vertical wall, since an inclined hole is difficult to tap, and the job when done is not satisfactory, as the threads do not bear on opposite sides of the well. For high pressure this procedure is not at all satisfactory.

Some years ago the author designed the well shown in the cut, and many have been made and used with entire satisfaction.

The making of an inclined well of this sort is not difficult, but calls for some explanation. One starts



DETAILS AND DIMENSIONS OF POCKET

with a rod 1⅝ in. in diameter or larger and 6 in. long. Lay off two sets of centers on the ends. Two centers fix the center line of the head and are 1 in. from the outer surface of the rod, on the same side. The other two centers fix the center line of the stem and are laid off on opposite sides of the center line of the head, the offsets being ⅜ in. at one end and ¾ in. at the other end.

Now set up the rod in the lathe, on the center line of the head, and turn the head of the well, with a cylindrical end and a ¾-in. standard pipe thread. The head can be made square or hexagonal, but it is just as well to make it round and use a pipe wrench to put the well in place. The head finished, set up the piece on the center line of the stem and turn the stem of the well. Then drill the well with a ⅜-in. drill.

If it is to be used in gas or superheated steam, fins should be turned on the shank, as explained by Mr. DeBaufre in the March 20 issue of *Power*, or as indicated by the dotted lines in the illustration.

When this well is screwed in place, a stick or screwdriver thrust into the hole in the well will indicate when it is right side up.

There are, in general, two systems of using pulverized fuel. The first, known as the storage system, utilizes a comparatively small crusher, together with a storage bin for the pulverized product. The unit system, however, does not require any appreciable storage, but instead includes a pulverizing equipment that is large enough to feed the boiler continuously at its maximum load. At lighter loads the fuel is fed at a slower rate to the pulverizer, whence it goes directly to the boiler.

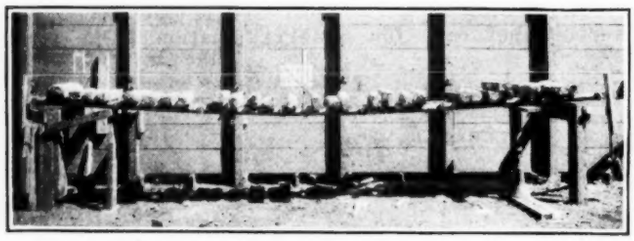
*The Detroit Edison Company.

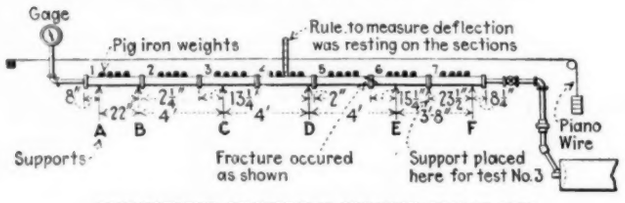
Cast-Iron Radiators for Refrigerating Coils

By H. J. MACINTIRE*

REFRIGERATION, as we understand the term at present, means the boiling of some volatile liquid in a suitable container. In America the liquid usually has been ammonia, and the container has been piping with the exception of the shell-and-tube brine cooler.

The ammonia passes into one end of the coil or length of pipe in liquid form with the exception of some





TESTS ON 7 SECTIONS LYING FLAT

Uniform Load of 300 lb. per Section

Ammonia pressure – 63 lb. per sq. in. at 11:10 A.M.
Ammonia pressure – 44 lb. per sq. in. at 12:00 A.M.

ARRANGEMENT OF SECTIONS FOR TEST JULY 28, 1922

Test Began 11:10 A.M.

Test No. 1

Support D removed, span 8 ft., No appreciable deflection. Results, no leaks

Test No. 2

Supports C and D removed, span 12 ft., deflection 1¼ in. Results, no leaks.

Test No. 3

Supports C, D and E removed, span 5 sections plus 2¼ in., deflection 3¼ in. Results, slight ammonia leaks.

But opinion prevailed that increasing the span 4 ft. would be too much, so the support was placed under the flange of sections 6 and 7.

Test No. 4

Supports C, D and E and temporary support removed, span 15 ft. 9 in., deflection 4½ in. Results, fracture between sections 5 and 6.

Test Ended 12:00 A.M.

FIG. 1—TEST ON SECTIONS LAID FLAT

10 per cent, which vaporizes during the pressure drop through the expansion valve. The remaining liquid absorbs heat like water does in a steam boiler and boils or vaporizes at a temperature corresponding to the pressure of the ammonia in the coils. The vapor then passes out of the pipes and back to the compressor. The ammonia compressor raises the pressure of the vapor so that it may be liquefied again in the condenser.

However, the cross-sectional area of 1¼- and 2-in. pipe is very small and the length of the coil may be 1,200 to 2,400 ft. and the ammonia gas must traverse the entire length of the pipe before it can get out. The disadvantage of this procedure is that some driving force is required to make the gas pass through the pipe, and the net result is that a much lower suction pressure is carried at the compressor end of the pipe than at the expansion-valve end. In addition, since the gas practically fills the expansion coils at the compressor end, the heat-transfer efficiency of the piping at this end is much reduced.

Radiator Design

The use of cast-iron radiators for heat transfer is not a new idea by any means, yet it is radical when considered for direct expansion of ammonia. For the purpose the cast iron must be thin-walled or the weight becomes excessive. It must be made of extremely dense metal and be free from shrinkage strains. It must be strong enough to withstand the maximum pressure which can be put on it, this being the condenser pressure with a liberal factor of safety. It should be reasonably safe against abuse such as unequal settlement of the supports or the carrying of commodities as a shelf, such as is sometimes required of it when erected in a position with the columns of the section horizontal.

The advantages of a radiator section for refrigeration, rather than piping, are practically the same as for heating. A large amount of surface can be secured in a small space, and it can be erected easily. The only requirement for a joint is to bring the flanges together and draw up on the four bolts. The cost of the section is about the same as for an equal amount of surface of pipe, and the space occupied is smaller. The usual method is to install an amount of surface of section equal to the amount of area of piping required, and the labor of erection is only that of making up on a gasket with a four-bolt flange, instead of having to cut pipes and make up with fittings.

The radiator section is conceded by many to be another advantage. The gas evolved by the boiling action has a tendency to rise and to enter the top header. The action then of the liquid is to pass along the lower header and boil up through verticals, thus frosting the entire section and permitting the gas to free itself easily from the liquid as soon as the ammonia as a gas ceases to be of value as a refrigerant.

Pressure Tests of Section

To make sure that the section is suitable for ammonia, it is necessary to make elaborate tests in the foundry because a cast section is all foundry practice. The only manufacturer selling ammonia sections at present (and the process is not patented) tests the sections with a water pressure of 400 lb. and then with superheated ammonia at 200 lb. The number of castings passing these tests averages about 85 per cent, and it may be said that the ammonia test is a real one, making use of the sulphur stick over every square inch of the section.

To insure ability of the section to take rough treatment, two sets of tests were carried out. The first was simply a test with water under pressure, and it was desired to prove that the section would not break under

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1,000 lb. Fig. 1 shows such a test, in which the average of six tests was 1,488 lb., or about 50 per cent in excess of the 1,000 lb. required in the proposed safety code of the American Society of Refrigerating Engineers which specifies that the refrigerating sections must have a

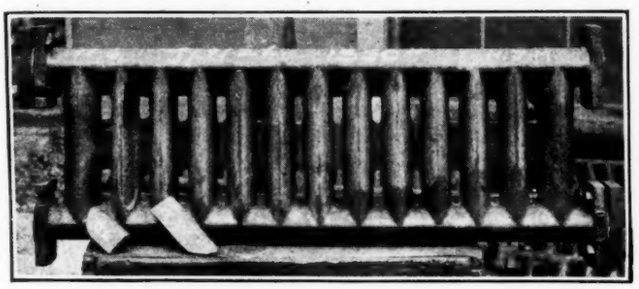


FIG. 2—RUPTURE OF SECTION UNDER HIGH PRESSURE

uniform thickness of $\frac{3}{16}$ in. The second test was to see what span the sections would carry under a superimposed load of 75 lb. per section for the sections with columns erected vertically, and with 300 lb. when the flat side of the section was set horizontally, this being the amount estimated to account for a full flood of ammonia inside the sections, the frost outside and commodities where the sections act as shelving, as in the case of sharp freezers. Figs. 1 and 3 show these tests which were made recently.

Deflections During Test

In each of these cases the row of sections was supported every four feet and loaded with pig iron as mentioned. Ammonia was allowed to pass into the section until a pressure of about 50 lb. was secured, and a piano wire was stretched along the row of sections in such a way as to permit reading on an inch scale the amount of maximum deflection of the span as the supports were removed one by one to increase the number of unsupported sections.

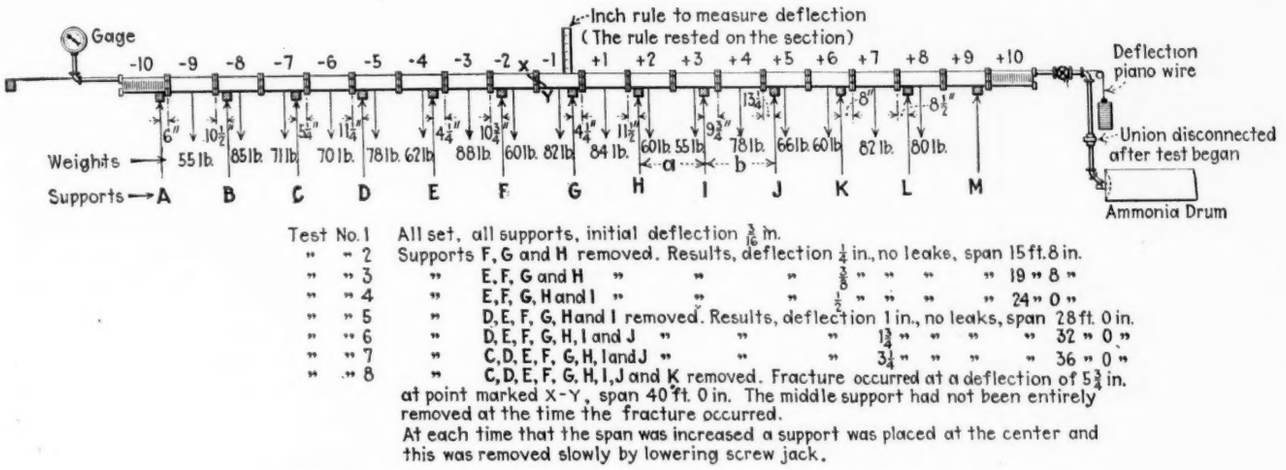
The sections with the columns vertical were found to carry successfully a span of 32 and 36 ft. respectively, and to take a deflection of $2\frac{5}{8}$ and $3\frac{1}{4}$ in. at the center. The section lying flat, as shown in Fig. 1, and loaded with pig iron to 300 lb. per section, took a span of 13 ft. 4 in. and a deflection of $3\frac{1}{4}$ and $3\frac{7}{8}$ in. in two different tests without failure. In none of these tests were there signs of ammonia leaks on testing the sections with a sulphur stick except just as they were about to break.

The conclusion so far arrived at from the tests are that cast-iron sections can be made safe for ammonia. If suitably erected, there is no danger, and should a support fail no serious trouble would occur; in fact, two successive supports could drop out and yet not endanger the plant. An excessive pressure, whereby the pressure increased on the low-pressure side until the safety valve began to blow at 250 lb., would not cause any damage, as the factor of safety is five at this pressure, eliminating all chance of fracture.

Being cast iron and not malleable, the sections should be guarded from blows or heavy shock. On the other hand, building vibration was found by a separate test to cause no difficulty.

Field Results

The cast section has been used for several years for brine, and it appears to be very successful for that purpose. For ammonia the application is new, and it is too early to give field results except to say that where they have been used the results have been good. The amount of ammonia charge in the system is somewhat greater than in the case of piping, except where the flooded system is employed. The author feels that where ammonia sections are tested in the foundry by a reliable manufacturer, they will be a success and will become popular as soon as refrigerating engineers are accustomed to their use, especially as the cast iron is not subject to the corrosion that occurs with steel or wrought iron, and, therefore, should have longer life.


Inch rule to measure deflection
(The rule rested on the section)
Gage
-10 -9 -8 -7 -6 -5 -4 -3 -2 X -1 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10
Deflection piano wire
Union disconnected after test began
Ammonia Drum
Weights → 55 lb. 85 lb. 71 lb. 70 lb. 78 lb. 62 lb. 88 lb. 60 lb. 82 lb. 84 lb. 60 lb. 55 lb. 78 lb. 66 lb. 60 lb. 82 lb. 80 lb.
Supports → A B C D E F G H I J K L M
a
b

Test No. 1	All set, all supports, initial deflection $\frac{3}{16}$ in.	
" " 2	Supports F, G and H removed. Results, deflection $\frac{1}{4}$ in., no leaks, span	15 ft. 8 in.
" " 3	" E, F, G and H " " " $\frac{3}{8}$ " " " "	19 " 8 "
" " 4	" E, F, G, H and I " " " $\frac{1}{2}$ " " " "	24 " 0 "
" " 5	" D, E, F, G, H and I removed. Results, deflection 1 in., no leaks, span	28 ft. 0 in.
" " 6	" D, E, F, G, H, I and J " " " $1\frac{3}{4}$ " " " "	32 " 0 "
" " 7	" C, D, E, F, G, H, I and J " " " $3\frac{1}{4}$ " " " "	36 " 0 "
" " 8	" C, D, E, F, G, H, I, J and K removed. Fracture occurred at a deflection of $5\frac{3}{4}$ in. at point marked X-Y, span 40 ft. 0 in. The middle support had not been entirely removed at the time the fracture occurred.	

At each time that the span was increased a support was placed at the center and this was removed slowly by lowering screw jack.

FIG. 3—RESULTS OF LOADING SECTIONS WHEN SET VERTICALLY

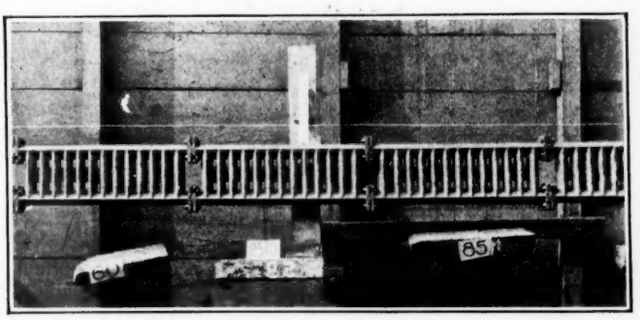


FIG. 4—METHOD OF LOADING SECTION SET VERTICALLY

Steam-Turbine Governors and Valve Gears —Characteristics of Hunting*

By EUSTIS H. THOMPSON†

WEAR, failure of parts or lack of attention sometimes causes unsatisfactory governing action in the steam turbine. Such difficulties, in comparison with the number of troubles in other machinery of power plants, are almost insignificant as a rule. Occasionally, unusual operating conditions occur, or a change of valve-gear design may be encountered, where governing troubles result that may require much thought, experiment, expense and delay, before a successful solution is developed.

A governor should adjust the speed of the turbine accurately according to the load and should correct the speed for a change or variation of the load in a smooth and positive manner. One of the most frequent faults is *hunting* or *surging*, the term applied when the action of a valve gear is not so smooth and positive as desired. This is usually due to friction or lost motion, although sometimes other causes are responsible. Either excessive or insufficient speed at no load or improper speeds under overload conditions are faults that occasionally occur, but usually are remedied easily.

HUNTING or surging of turbine valve gears is seldom referred to in print. Although not of frequent occurrence, such troubles may cause great expense and inconvenience. The subject is not generally understood as thoroughly as other departments of turbine operation; discussions from those experienced in overcoming difficulties of this kind are invited. In this article governor operation with slow changes of load is contrasted with the difficulties encountered when sudden large load variations occur. The general condition known as "hunting" affects alternating- and direct-current units differently. Friction, lost motion, sprung spindle and worn thrust bearings are discussed.

Turbines driving direct-current generators are not, generally speaking, as sensitive to governor misadjustment as those connected to alternating-current machines. In the former, equalizers connecting the two generator windings compensate to some extent for irregular governor action, while in the latter case there is no equalizing effect to distribute load surges. Speed surges readily cause small variations in the division of the load between generators which may develop into cross-currents of large amount and cause serious operating inconvenience.

When a direct-current unit is placed in operation, it is only necessary to adjust the voltage by hand before closing the switch. The governor may allow the speed to vary one per cent or more without causing appreciable inconvenience. An alternating-current unit, on the other hand, in addition to accurate voltage, requires the frequency of the generator to be in synchronism, so that the incoming machine will have its voltage in phase with that of the machines already on the line. This means that the speed must be capable of being adjusted so that the electrical impulses practically coincide before the switch can be closed. The speed must be correct to at least one-twentieth of a cycle, on closing the line switch. This represents an accuracy of 0.08 per cent of the speed in revolutions per minute. If irregular governor action occurs, this delicate adjustment will be made difficult or in some cases perhaps impossible.

The auxiliary device for changing the speed also adds another complication to this type of governor. The governor mechanism of a large alternating-current unit is therefore more complicated than that of a direct-current unit. Special conditions are sometimes encountered, so that governing troubles are much more frequent than in direct-current units.

The most familiar form of governor trouble is usually called *hunting*. Other names applied to this condition are "racing," "surging," "oscillating" and "overtraveling." This trouble may occur in turbine or engine governors or in electrical regulators where a definite amount of material or mass must be moved in order to accomplish the governing action. When present in only a slight degree, it may be noticed in the valve gear itself without affecting operation undesirably. When existing in a greater degree, it causes variations of the load which are objectionable. The same degree of hunting causes more inconvenience in alternating- than direct-current units. Friction or lost motion is accountable for most of this trouble, although other causes sometimes are responsible.

Fig. 1 shows the general form of a direct-connected valve gear where the governor spindle actuates the steam valve through one or more links, with no mechanism to supply auxiliary power such as hydraulic gear or mechanical lifting device interposed between the governor and steam valve. The centrifugal force supplied by the governor itself is sufficient to operate the valve. The no-load position, in which the valve is nearly closed, is indicated by position 1, Fig. 1. If the generator operates at full load with a normal speed of 1,800 r.p.m., with a regulation of 2 per cent, this position will represent 1,836 r.p.m. when no load is on the turbine. Position 2 is for one-fourth normal load, approximately 1,827 r.p.m., and the remaining positions indicate an addition of one-fourth load each time, so that position 3 is one-half load, 1,818 r.p.m.; position 4 is three-fourths load, 1,809 r.p.m.; and position 5 is for full load, 1,800 r.p.m. In practice the speeds do not come at such regular intervals and the one-fourth load point might be expected at 1,825 r.p.m. and the valve opening will admit somewhat more than one-fourth of full load steam, as the turbine is less efficient at light loads and the friction losses are higher in proportion, requiring a greater steam consumption per kilowatt-hour.

In order to visualize the governing action, we will

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assume that the machine is carrying one-fourth load with the governor weights at position 2. An additional load of one-fourth normal is *gradually* placed on the generator. The turbine will slowly drop in speed and the valve will gradually open until the one-half load position is reached, at which point the valve will admit enough steam to carry the load and the generator will run at a speed of 1,818 r.p.m. approximately.

Suppose now that very small changes of load are made for short periods of time but that the average load being carried is one-half normal. With such small changes of load, say one-thousandth of full load, the governor ordinarily will not cause any change of valve position. If this infinitesimal load is taken off for ten seconds, the turbine will speed up a very little. If this decrease in load, however, should continue for several minutes, the speed would rise enough to cause the governor to close the valve a little more. The speed could thus fall slightly without causing any movement of the valve, since with small loads the valve does not move in exact relation to the load. Advantage is taken of the flywheel effect of the machine to give and take energy to meet these small load variations. By reason of the flywheel effect a larger change in the load can come and go intermittently for short periods of time without moving the steam valve.

If a governor responded to every load variation, all friction and lost motion would have to be eliminated, which is not practical. A small amount of friction and lost motion is present in every valve gear and is desirable rather than otherwise. In practice, however, it is seldom possible to make these quantities too small; in fact, it requires care to keep them from becoming too large, for it is usually desirable to decrease friction and lost motion to the lowest possible extent. Under some conditions special friction is necessary and dashpots are provided, but these are usually for the purpose of dampening out surges or variations that result from the special construction of the valve gear.

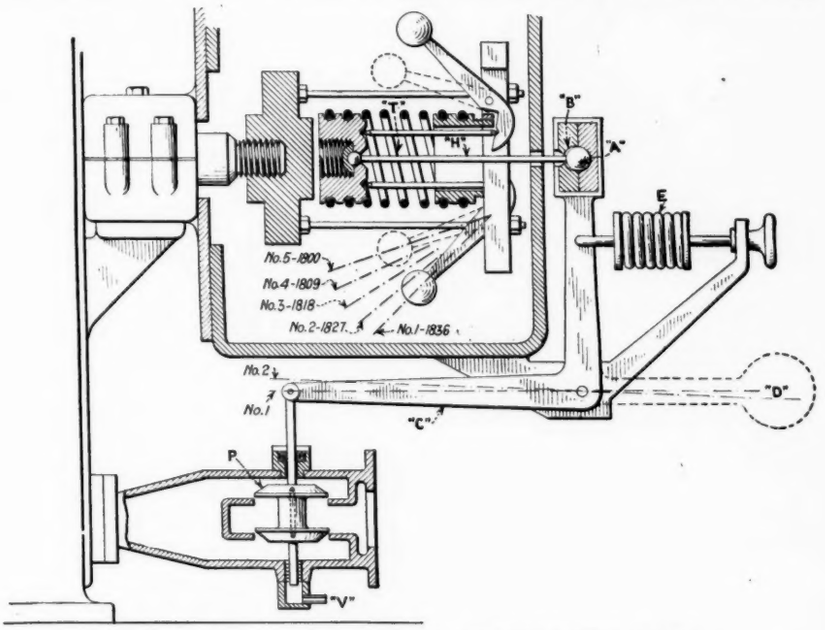


FIG. 1—GENERAL SCHEME OF DIRECT-ACTING GEAR ON TURBINE SHAFT

Here the governor weights are linked to the main valve, which is moved by the force of the governor without the aid of an oil-operated piston.

Sudden Addition of Load Produces Small Lag in Governor

Next let it be assumed that the turbine is operating at one-fourth load when one-quarter more load is suddenly added, making altogether one-half load. The set will now slow down more quickly than before, as its flywheel energy will be used up at a more rapid rate than where the load is put on very gradually.

On account of the friction and the time required for the governor spring to move the mass with which it is connected, the valve will not follow the speed change as closely as in the first case, but will open much more slowly. When 1,818 r.p.m. is reached, the valve will be considerably less than half-way open. The speed will continue to fall until the valve reaches its half-load position, which will cause the speed drop to be checked but not instantaneously. When actually checked, the valve will be open wider than half-load position. The speed will now slowly rise, as the valve will have been opened somewhat more than halfway, say in the position for 1,823 r.p.m., at the time the speed was actually checked in its fall. Since this valve opening is more than required for the load, the turbine speed will rise, but this takes place much more slowly than the original fall of speed. The valve movement, therefore, will follow closely and stop the rise in speed at the 1,818 r.p.m. position, where the valve opening will be just right for one-half load.

In summarizing the action so far, we find that the governor causes the valve to follow the changes in speed that occur in a normal manner, but for exceedingly small variations of load that act for short intervals of time, the governor will not be required to regulate. For sudden surges of load that are abnormally large and that may either be thrown on the generator or taken off, the valve will not follow the changes of speed accurately, but will lag behind to some extent and will cause a small reversal in speed before correcting properly. The turbine unit is considered as operating alone and not in parallel

Friction in Relation to Hunting

Friction, binding or sticking will cause the valve to lag to a greater extent behind a sudden change in speed, and excessive friction will cause a lag even when normal changes in load take place. With excessive friction the inaccuracy of adjusting the valve position is greatly increased, producing a greater amount of speed variation before being checked. When the speed drops, excessive friction prevents the governor from moving the valve until the speed has lowered a considerable amount, whereupon the governor overcomes the frictional resistance and shifts the valve open beyond the point necessary to carry the load. The speed of the turbine due to the excessive valve opening may rise once more before the valve is stopped at the proper position. Sometimes the friction may cause a valve to lag so much that many reverses of speed occur before stability is secured.

When the load is constantly varying and a heavy friction exists, the valve will not have time to correct itself to any change of load, and the speed will be changing up and down continually. The governor will appear to be opening and closing the valve rapidly in a continuous manner, usually called hunting or surging. Such governor action as just described is supposed to be characteristic of a machine when operating alone. When other machines are in parallel with it, the surging effect will be somewhat dampened if these are direct-current generators, as more load will be taken on when

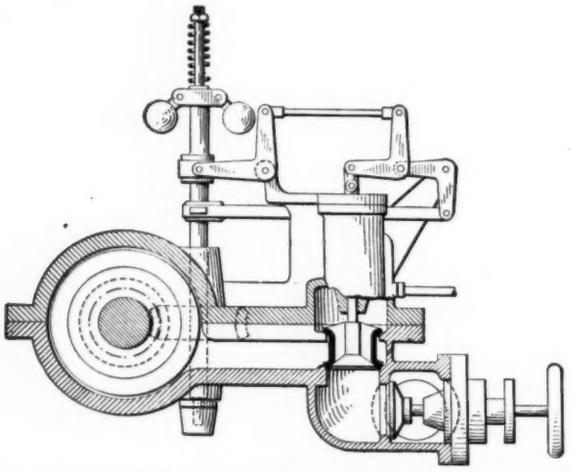


FIG. 2—DIRECT-ACTING GOVERNOR GEARED TO HIGH-SPEED TURBINE SHAFT

overspeed occurs, and the load will be decreased at the low-speed point. With alternating-current generators a certain period of vibration in this load exchange takes place so that the effect may become magnified and produce worse results than if the generators were operating independently.

Slow Hunting Changes the Load, but Rapid Hunting Causes Cross-Currents

Hunting may occur on an alternating-current unit operating in parallel with other units, where the oscillations or surges produced by the governor are fairly slow in periodicity such as from five to twenty per minute. The effect produced is usually to make the unit take first an excessive load and then to drop this and carry less than its share of load. The speed of the other machines in parallel is increased somewhat on account of their giving up part of their load. When the opposite part of the oscillation of the defective governor takes place, the generator carries less than its share of load. The other machines then carry more load and consequently slow down. Slow surging, therefore, causes the speed of a machine that is in parallel with other alternators to vary up and down.

If the governor oscillates at a high rate of speed, the general effect on varying the speed of the system is much less because the flywheel energy is a larger proportionate factor. Small changes of load are quickly given and received by the unit that is hunting. The quick exchanges of load are sometimes called cross-currents. It may happen that a regular period of vibration in giving and taking load is set up due to special conditions of valve gear or generator design. This vibration in current may become worse and is sometimes increased to such an extent that the main switch is tripped out.

If friction exists throughout the entire travel of the moving parts, the hunting effect may take place at any load. When friction exists for a short period of the travel, this hunting action will be found only at the loads that cause the valve gear to take the position where this friction occurs.

Friction that exists in spots is usually referred to as binding or sticking. Sticking may occur at one small point of the governor travel and cause a jerking action rather than the smooth pulsations of the valve gear that are noticed in ordinary hunting where the friction is of an even character.

Friction may occur at any point in the governor mechanism from the moving weights of the governor to the steam-valve element. This may be operated by the governor directly or through the agency of hydraulic gear, mechanical devices, etc.

When the friction which acts in an excessive degree is constant and steady in its effect and takes place equally throughout the entire range of governor regulation, the oscillations produced by change of load will gradually die out and leave a steady condition of the governor provided the load is not subjected to further change and steam and exhaust conditions are constant. Where the load varies at frequent intervals, the oscillations will be set up at each change of load, and if the variations of load are sufficiently close together the governor will never reach a period of rest.

If the governor is allowed to come to rest on a constant load, the oscillations may be renewed if the steam pressure varies. A sudden fall in steam pressure would mean a slowing down of speed and consequently a larger valve opening in order to carry the proper load. This movement of the governor would subject it to oscillations in order to make the proper alteration in valve opening. In ordinary practice changes of load, steam pressure, and possibly changes of vacuum or back pressure, usually keep the valve gear in a constant state of oscillation or hunting when an excessive friction exists.

Effects of Binding or Sticking

When the valve gear sticks or binds at certain points, hunting will be set up whenever the governor position brings the valve gear into these points of sticking. This is usually a jerky motion rather than a regular surging effect. If the output of the set is sufficient to keep the valve gear away from the sticking points, good operation may be expected. Steam valves sometimes stick at light loads and are free at heavy loads, so that hunting occurs at light loads while the operation is satisfactory with heavy constant loads. Binding or sticking sometimes exists to such an excessive degree that the governor is not able to move the valve gear in the position where binding exists. If this occurs at a small valve opening, the machine will fail to carry over loads properly and may run away at no load. If this occurs at a wide valve opening, the machine may overspeed at heavy loads, but run well at lighter loads.

Lost motion is usually present to some extent in all valve gears. Only a small amount is necessary as "clearance" in the governor thrust bearing. This runs ordinarily from 0.0015 to 0.005 in. A small amount of lost motion usually occurs at each joint of the mechanism of a valve gear. In almost all gears spring tension or the force of gravity tends to take up lost motion so that, ordinarily, any appreciable variation of load will cause a corresponding change in the governor position.

Suppose that an excessively large clearance has become worn at *A*, Fig. 1. It will be noticed that the bell-crank lever is heavy on the overhanging arm at *C*, holding transmission bearing in contact at *A*. For slow motions of the governor this contact will be maintained and the actual governor action will be satisfactory. On the other hand, if the governor makes a quick pull in toward the shaft, the thrust ball may leave the side *A* and touch the side *B*, which will give the valve a jerky motion, causing a surge in the turbine speed.

On the other hand, suppose the weight *D* as shown in the dotted lines were to counterbalance the pull of gravity, holding the thrust bearing positively in the position shown. If the thrust ball is in contact at *A* and the load increases, the thrust ball will move toward *B*. The governor lever will not move until the lost motion has been taken up, as it is in gravity equilibrium. It will be necessary, then, for the governor weights to move a greater distance before the steam-valve opening is altered and the governor speed corrected.

After the speed is correct, the inertia of the governor lever may cause the thrust bearing to travel past this point until it makes contact again at *A*. It is apparent that when the moving parts are exactly balanced, lost motion of an appreciable amount will cause a constant movement and hunting of the valve gear. Ordinarily, valve gears which approach this condition usually have a spring *E* for the purpose of holding the thrust ball in positive contact in one position and thus prevent surging. Alternating-current turbines or those driving auxiliaries, are equipped with springs for varying the speed, and these also tend to take up the lost motion in a similar manner.

Another effect is apparent where the thrust bearing is worn at *A*; this will allow the steam valve to be lowered somewhat, causing a lower no-load speed and a smaller capacity of the turbine at full speed. With other types of levers the effect of wear may be to lift the valve and cause the machine to run away at no load, instead.

Oscillations Due to Spring Valve Stem

Rapid reciprocating or oscillating of the valve gear is sometimes set up by abnormal mechanical conditions. In Fig. 1, if the governor spindle becomes bent or sprung at the point *H* near the transmission bearing, the bell-crank lever will tend to move from one side to the other on account of the movement of the transmission bearing. This would have the effect of causing slight pulsations in the valve itself. Sometimes the thrust ball becomes worn out of round or a ball may break in a ball-race thrust bearing. Each of these conditions would produce an oscillating movement of the valve. These oscillations would ordinarily coincide with the speed of the governor and set up rapid fluctuations of speed in the generator. This would not cause special inconvenience in a direct-current unit. In an alternating-current unit cross-current might be set up, depending on how much the valve would be moved at each oscillation. In addition to oscillation the adjustment of the governor would probably be disturbed, and heating or mechanical vibration would be expected. High-speed oscillations of this character, usually have little effect comparatively on parallel operation. Bad alignment of the governor parts will sometimes cause oscillation. Other causes will be taken up in connection with special types of valve gear.

The governor of the machine in Fig. 1 is direct connected to the shaft and operates at the same speed as the turbine. In other types of valve gear the governor may be geared to the shaft, Fig. 2, so that it runs at a much lower speed. Oscillation set up for mechanical reasons are here much slower and may make more difference in the speed of generators and may cause heavy cross-currents with parallel operation. Excessive clearance of the gearing at the governor shaft sometimes produces oscillation of the governor spindle which may or may not be serious.

General Summary

Hunting or surging is more troublesome, relatively, on alternating-current than on direct-current units.

Large changes of load that take place slowly, are easily corrected by governors. Load variations that act for small or minute time intervals are taken care of by kinetic energy or flywheel action, rather than by minute governor regulation. A small amount of friction or lost motion in a valve gear is desirable rather than otherwise.

Large changes of load that take place quickly cannot be corrected as accurately by valve gears as the foregoing conditions.

Abnormal friction increases the lag of the governing action. Slow and fast governor oscillation of an alternating-current turbo unit in parallel may vary speed or set up cross-current.

Friction or binding may produce temporary or continuous hunting. Binding or sticking that affects the gear when in only one governor position, may set up hunting or jerking at certain loads.

Lost motion is usually neutralized by gravity or spring pull, so that it does not affect governing action adversely. Where there is no such steady pressure, a constant surging may be produced by excessive lost motion. Quick variations of load may produce improper governing action if abnormal lost motion exists.

Oscillations set up by sprung spindle or other governor mechanical troubles cause variations of the same speed as the governor.

Crankshaft Alignment

By J. E. Great

There are a great number of Diesel engines in operation today giving apparently good and satisfactory service, in which the crankshafts are suffering undue strains and alternative stresses caused by misalignment of the bearings. Regardless of how well and accurate the alignments were determined and checked at the time of erection, a rechecking will always prove worth while. Recently, while inspecting a 250-hp. horizontal Diesel engine which was in operation, I placed my hand in the inspection hole on one of the main bearings and, pressing my fingers between the journal and bearing shell, felt what I thought was excessive vibration.

I approached the chief engineer on the matter and asked if this vibration could not be eliminated by reducing the amount of clearance between the journal and bearing. His answer was that he had just adjusted the bearings and if the clearance was reduced any more the bearing would heat up. He further explained that it was nothing to worry about, that all Diesels were subject to peculiar vibrations, strains and stresses, etc. This may be true, but I believe the chief

trouble is that too many engineers are willing to adhere to the stone-age idea that all vibrations are due to peculiar Diesel conditions, and that in almost all cases an investigation will show that the vibration can be eliminated.

I rigged up and placed a dial test indicator on the main bearing, as shown in Fig. 1, and found that the indicator registered a journal vertical displacement of 0.18 in. I then tightened up on the bearings until these vibrations were reduced to 0.002 in all main bearings. After running about fifteen minutes longer, the bearings began to warm up, and I had this engine taken off the line and the load put on another unit in order to find the reason of this heating.

Experience should determine the minimum clearance under which a bearing will operate most satisfactorily, and it should be adjusted as close as possible without running hot. Bearings vary a little as to the proper amount of clearance they require, as do also the opinions of the fellows that adjust them, and their proper adjustments should be the product of conclusive study involving experience, operating condition and good judgment. A dial test indicator is a great aid in the adjustment, as one can readily detect shaft vibration in thousandths and compensate accordingly.

For example, in a bearing having a shim adjustment the vibrations or play can be determined while the machine is in motion and a notation made of the same. When opportunity is afforded, the vibration can be reduced. Suppose the play was 0.012 in. and the desired clearance was 0.003 in.; by removing 0.009 in. one has the desired clearance. This method has proved satisfactory where the bearings were accessible.

To ascertain why these bearings warmed up after they were adjusted to their proper clearance, I concluded

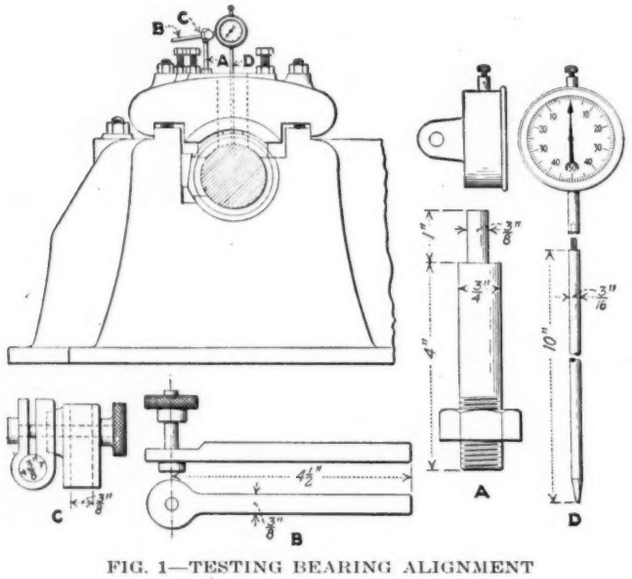


FIG. 1—TESTING BEARING ALIGNMENT

that the excessive friction was due to misalignment, so I checked the alignment and remedied it as follows: After removing the hoods and cleaning the crank webs, I smoothed off with a file the crank webs at the points where the measurements were to be taken, then inscribed a circle about ⅛ in. in diameter, which determined one point for the inside micrometer; the other point was located by feel. The engine was now turned to the crank-up position and the dimensions *A* and *B*, Fig. 2, were found, which were *A* + 0.024 in. and *B* + 0.034 in. The engine was now turned 180 deg., or to crank-down position shown in broken lines, and dimensions *C* and *D* were found, *C* being 0.0315 in. and *D*, 0.039 in. These dimensions indicated that the crankshaft was operating under a strain, for the measurements *A* and *C* should check if the shaft is in align-

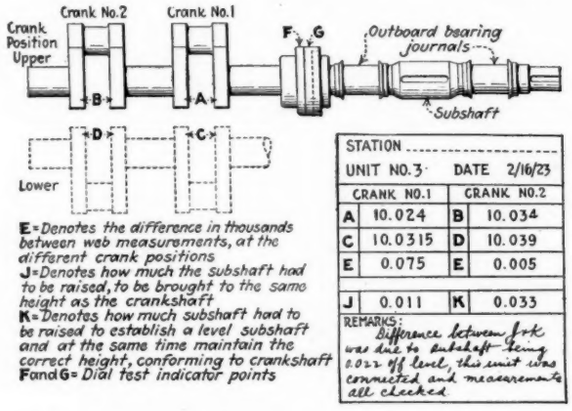

Crank No.2
Crank No.1
Crank Position Upper
F
G
Outboard bearing journals
B
A
Subshaft
D
C
Lower
E=Denotes the difference in thousands between web measurements, at the different crank positions
J=Denotes how much the subshaft had to be raised, to be brought to the same height as the crankshaft
K=Denotes how much subshaft had to be raised to establish a level subshaft and at the same time maintain the correct height, conforming to crankshaft
F and G= Dial test indicator points
STATION
UNIT NO. 3 DATE 2/16/23
CRANK NO.1 CRANK NO.2
A 10.024 B 10.034
C 10.0315 D 10.039
E 0.075 E 0.005
J 0.011 K 0.033
REMARKS: Difference between fork was due to subshaft being 0.022 off level, this unit was connected and measurements all checked

FIG. 2—METHOD OF CHECKING SHAFT ALIGNMENT

ment and here there was a difference of 0.0075 and a difference between *B* and *D* of 0.005 inch.

The dial test indicator was next placed on the crankshaft of the rigid coupling at *F*, the indicator being fastened to the engine frame and the dial adjusted so that the reading was zero. The tapered bolts securing the coupling were removed to relieve the crankshaft of the weight of the sub-shaft and flywheel. The shaft then returned to its original state, and the amount of movement was recorded by the dial test indicator, being 0.022 in. low. However, before any change of the bearings was made, the indicator was moved to the subshaft part of the coupling at *G* and the dial adjusted to zero reading. The outboard bearing nearest to the crankshaft was raised by adjusting the wedge the same amount in thousandths that the dial registered when the crankshaft returned to its original state. The off outboard bearing was next raised to a point where the sub-shaft was level. The shaft and sub-shaft were now in true alignment. To prove this, leaving the coupling-pin bolts loose, measurements were again taken at *A*, *C*, *B* and *D* with the crankshaft relieved from all strain. These measurements checked, proving that the bearings are all in alignment. If a deflection is shown, the bearings are not in line and should be corrected. Since they checked, the coupling bolts were drawn tight, and *A*, *C*, *B* and *D* measured again with the sub-shaft attached. I have found that the slightest deflection in the crankshaft can be ascertained if the measurements between cranks are accurately made with inside micrometers.

I wish to say that this was one of ten Diesel crankshafts that I have tested recently, and out of these ten only one was found in alignment.

There are two methods of pulverizing coal in use. By one the coal is hammered or crushed by revolving hammers against anvils; in the other, hammers or vanes are rotated at high speed and come in contact with pieces of coal, which they crush by impact only. In the latter method coal is actually cracked while in the air, and the fine particles are readily blown away.

EDITORIALS

F. R. LOW, EDITOR

Keeping an Open Mind on New Developments

DURING the last few years—and now more than ever—new things have been crowding upon our attention in the power-plant field. Powdered fuel, low-temperature carbonization, house turbines, hydraulic ash removal, extremely high pressures, electrically driven auxiliaries, bleeder heating of feed water, evaporators, degasification of feed water, bleeder and mixed-pressure turbines for manufacturing plants, high-pressure steam accumulators, stage reheating of steam, air preheaters and the utilization of the heat in generator cooling air are typical examples of the new developments upon which designing and operating engineers must pass judgment. Things move so rapidly these days that some of the developments mentioned—the house turbine for example—have already passed into the "conservative" class. Others, such as the air preheater, are thoroughly established abroad, but have not yet made much headway in the United States. This does not mean that American engineers are more backward than those in Europe. The lower relative price of fuel in this country naturally postpones the time at which foreign fuel-saving devices become economically practical here.

A third class of new developments comprises those that are still in the tryout stage all over the world. The outstanding example of this class is the very-high-pressure boiler—800 lb. and up, say—which is now the subject of large-scale experiments in Sweden, England, Germany, the United States and other countries.

In view of this great activity among the pioneers it behooves the average engineer to keep in close touch with what is going on at the outskirts of his field and above all to keep an open mind without losing any of that practical good sense that is characteristic of engineers as a body. It is, of course, unreasonable to expect the owner of the average small power plant to take a chance with untried equipment even where it gives every promise of a handsome saving. Such experiments must be made, or at least must be backed, by the manufacturers and the larger power-generating companies whose output is sufficiently large to absorb the cost of experimental work.

But it is one thing to decide that a certain piece of apparatus or method of plant operation has not yet been sufficiently tested to warrant immediate adoption by the rank and file of power plants, and quite another to make up one's mind without careful investigation that the new development is "all right in theory but will never work out in practice." Things that do not work out in practice are not all right in theory. Failure in practice is simply a demonstration that the theory is incorrect or omits the consideration of some vital factor. Practical tryouts are, of course, essential in almost every case, for the simple reason that our theory is incomplete, which is only another way of saying that engineers are not omniscient.

It is a fact, nevertheless, that mechanical theory has now reached such a stage of development that when thoroughly competent engineers pronounce a radically new design all right in theory, its chances of commercial success are too high to make condemnation without trial a safe procedure. The only safe course in such cases is to give every encouragement to those who are ready to make practical tests and run the risk of failure.

Standardization of Distribution Voltage

EARLY development in the electrical industry was accompanied by the adoption of a large number of frequencies and voltages. Fortunately during the last ten or fifteen years most of the frequencies have been practically eliminated with the exception of twenty-five and sixty cycles, which are becoming standard. With regard to distribution voltage, conditions are not so favorable, although during the last ten years much has been done toward adopting standards. However, there are still in use about twenty different voltages for lamps in the range from one hundred to one hundred and thirty.

In the days of the carbon-filament lamp this wide range of voltages had certain advantages, since the manufacturers found it difficult to gage properly their product for a small number of voltages. The introduction of the tungsten lamp removed these limitations, and lamp manufacturers began a campaign for a more limited number of voltages, centering their attention largely on 110, 115 and 120. This has had a healthy effect toward standardization, and last year over eighty per cent of all lamps sold were for these three voltages.

Since 1920 the National Electrical Light Association has been giving attention to the whole problem of service voltage standardization to determine what would be the most desirable voltage and if departures were necessary, what the departures should be. In order that every branch of the industry might be represented, a special joint committee was organized, representing the manufacturers of apparatus and the users, not only to study the question of service voltage from the angle of lamp standardization, but to give careful consideration to the requirements of appliances, motors, control equipment, etc. The work of this committee is not completed, but its tentative recommendations lay great emphasis upon the fact that 115-volt service should be recognized as the preferred standard and that other voltages of existing systems be changed when practicable to the standard, as given in this year's N.E.L.A. Electrical Apparatus Committee's Report.

If these standards are adopted, and no doubt they will be, it will require time to attain a complete standardization. Where systems have been operating on 110 volts, it will in most cases be only a matter of adjusting the voltage of the generators to give the average standard voltage (115) and gradually replace the lamps

for this voltage. As far as the motors on the system are concerned, they more frequently operate at a voltage below their rating than at rated potentials or above, so that a four or five per cent increase in system voltage will be beneficial. Furthermore, standard motors are generally designed to operate satisfactorily on a ten per cent variation in voltage from normal. In most cases there would be a more serious objection to a reduction than to an increase, on account of the voltage already being below normal.

The most serious objection is probably that 115 volts is not an exact multiple of 440, which is the voltage that has come into wide use for polyphase motors. However, the former is an exact multiple of 2,300, which is a standard distribution voltage, where 440 is not. As these are alternating-current voltages, they can be taken care of easily in the transformer ratio. Although this standard is being promulgated by the central stations and manufacturers of electrical apparatus, every industrial plant in the country has an interest, because when the recommendations are adopted as a standard, they will eventually remove from the electrical industry one of the troublesome factors in the application of light and power equipment.

How Higher Temperatures Affect Pipe Fittings

THE application of high temperatures and pressures is widely recognized as introducing grave problems into the design of pipe fittings. Increase of temperature is known to decrease the ultimate strength of materials very rapidly above 700 deg. F. On summing up the situation, however, other factors appear of equal or greater importance in regard to the problems that are introduced.

Higher temperatures, especially when used in conjunction with increased pressure, will require thicker pipe, which will be relatively heavier and stiffer than at present. Increased weight will make the problem of pipe support more serious. Bending strains in the line may stress the bolts holding the joints above the allowed limit. Stiffer pipe, with resultant increased expansion, will require more careful provision for expansion and flexibility. Springs or other flexible supporting members that are placed close to the pipe may become weaker if heated, and should be used with caution. If expansion is restricted appreciably, the bolted joints may again be subjected to excessive strain.

A third condition affects bolts adversely. In heating up to normal temperature, the flanges heat first and the bolts last, since heat enters by contact at the ends of the bolts, though in some cases the bodies are partly heated by radiation. Expansion of the flanges, which precedes that of the bolts, tends to over-strain the latter and weaken the joint. Some elasticity of the flanges is desirable in compensating for any of the aforementioned three abnormal strains that may take place in the bolts. Thick pipe flanges are considered objectionable in some cases, on account of molecular strains that result from unequal expansion, with consequent weakening or distortion. Flexibility, which is a marked characteristic of foreign practice in designs of this kind, is apparently a vital factor.

There is another condition incident to increasing temperature which has a more important bearing on the subject than those previously mentioned. Although the decrease of tensile strength is marked, yet the reduction by high temperature of the elastic limit, or stress where a permanent set may be produced, is comparatively greater. Therefore, in the face of an increased demand for flexibility we encounter a growing inability to supply it. Evidently, one result will be to avoid, as far as possible, bolted joints for temperature extremes. Keeping pipe diameters from increasing over a certain amount by utilizing multiple lines is a method of securing flexibility. Four inches is spoken of as the maximum size of pipe under extreme conditions from the present outlook. The avoidance of all except the two end joints by employing short straight pipe connections to movable prime movers of special construction and location, is another possibility, hinging on the employment of reheating cross-compound turbine units.

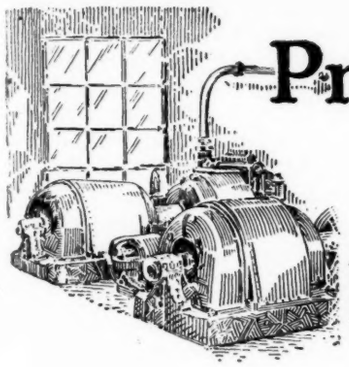
Elevator Controllers Reached High Degree of Perfection

IN A large proportion of important hotels and office buildings and in industrial plants, electric elevators are part of the equipment. The elevator machine has been developed to a point where it is one of the safest methods of transportation, even though it travels in a vertical direction. This high degree of safety is due to a number of factors, of which the control equipment is of prime importance. In this issue is an important article, on the "Operation of a Gearless Traction Elevator Controller."

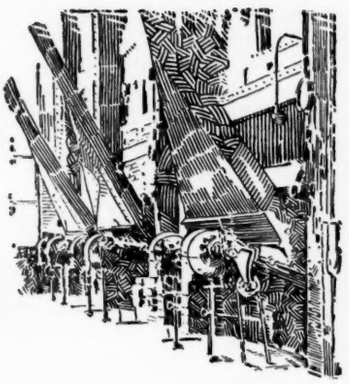
In so far as straight rheostatic control for elevator motors is concerned, this equipment represents one of a high degree of refinement. Six distinct speeds are obtainable with automatic slow-down at the terminal landings, involving a feature that allows the car to come to about the same level automatically with or without load. In addition to this, there is governor control of the shunt field to prevent racing in the down motion under heavy loads. These controls, as might be expected, are somewhat complicated when looked at as a whole. However, if each function is considered independently, it will be found that they are comparatively simple and may be easily understood by anyone who has an elementary knowledge of electric circuits. It is in this light that this controller should be studied.

Instead of having a separate controller to perform each one of a dozen or more operations, all are combined into one, and it must be expected that the number of circuits will be in proportion. The scarcity of published information on such equipment makes this article of double importance, since high-speed traction elevator machines are coming into such general use and are part of the equipment looked after by the men responsible for the electrical and mechanical apparatus in the plant.

There is much discussion on the efficiency of manual control and automatic control of substations and hydro-electric plants. Laying aside the question of economics, the properly trained operator is as proficient as his competitor, the automatic control. In handling a large hydro-electric unit, both are capable of starting it from standstill, synchronizing the machine and putting it under full load in about 30 seconds. The record is probably in favor of the manual operator, with a time of twenty-one seconds for a ten-thousand-horsepower unit. Of course, the largest hydro-electric plant under automatic control is only five thousand kilowatts, which is small compared with some of the units under manual control.



Practical Ideas *from* Practical Men



Keeping Mechanical Records

An important detail in the operation and maintenance of the mechanical department of an iron mine is that of securing complete data on all the equipment.

For our own mechanical department we use only one style of card for every subject; the size is 3 x 5 in. On this type card a detail record can be made relative to any subject in the department. The following will explain the card system and the manner in which it is kept:

A card cabinet (Globe-Wernicke) with three drawers is used for the cards, each drawer having a set of 80 buff-colored alphabetical guides with red letters. Drawer No. 1 is labeled, "Operating Data," and a subject from this drawer is shown on the card, Fig. 1. From this drawer we can obtain the sizes of all the equipment that is in operation without leaving the office, such as engines, type, size and speed, boiler, type, size and pressure allowed, pumps, type, size and capacity, etc.

Drawer No. 2 is labeled "Repairs." A subject from this drawer is shown on the card, Fig. 2. Any repairs that are made on any of the equipment are recorded on a separate card and filed in the alphabetical index under the proper heading. This card shows what repairs were made, the time required to make them and the date they were made.

Drawer No. 3 is labeled "Records." Any subject that should be recorded can be filed in this drawer. If

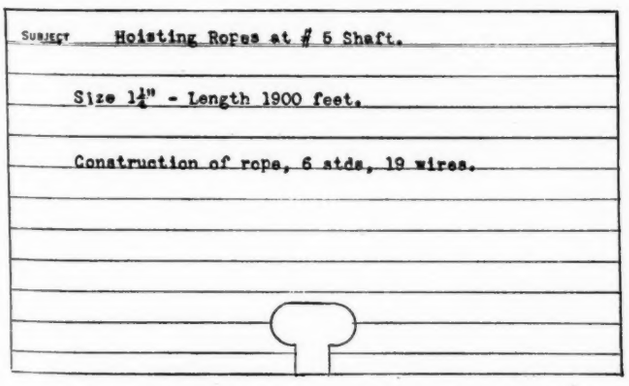


FIG. 1—CARD USED TO RECORD SIZE AND DETAILS OF EQUIPMENT

necessary, both sides of the card or two or more cards can be used for the same subject. The cards in this drawer show the date that any of the equipment was installed, time required for installing, date it was put in operation, also the time when boilers were cleaned last and when hoisting ropes were put in operation, length of service, date at which they were removed, etc.

The alphabetical index in each drawer is comparatively large, which makes it easy to find any subject, and as already mentioned, it is under headings, and when anyone in the department wishes to know the size of any of the equipment, he will look in the operating

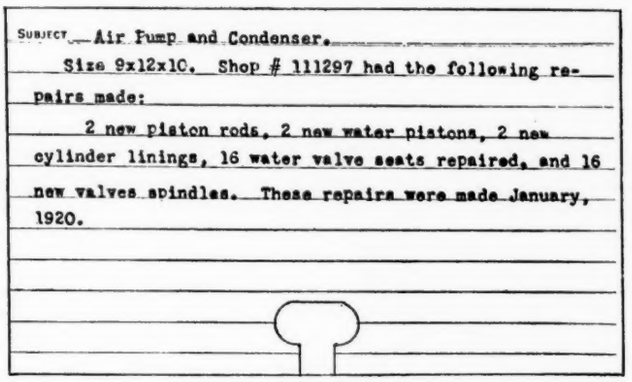

Subject Air Pump and Condenser.
Size 9x12x10. Shop # 111297 had the following repairs made:
2 new piston rods, 2 new water pistons, 2 new cylinder linings, 16 water valve seats repaired, and 16 new valves spindles. These repairs were made January, 1920.

FIG. 2—GIVE DETAILS OF REPAIRS MADE

data drawer, for the date any repairs were made, in the repair drawer, and for time any change was made, he will look in the record drawer.

T. J. PASCOE.

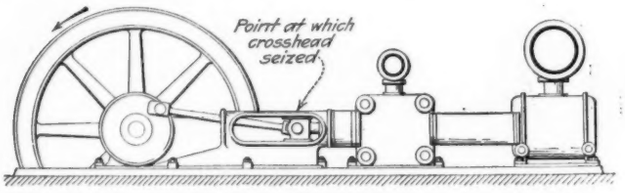
Norway, Mich.

Low Temperature Causes Seizing of Crosshead

In the plant where I am employed there is a large steam-driven air compressor of the cross-compound type, which runs at 80 r.p.m., and on several occasions we have been troubled by seizing of the crosshead in the guides, which are of the bored type. The crosshead is fitted with cast-iron shoes and is well lubricated. The trouble generally occurred when starting the machine in the morning, and only at long intervals of several months, during which time the machine would run without any sign of heating. At first it was believed to be due to grit on the guides, but after it had occurred several times, observation showed no evidence of this, consequently we had to look elsewhere for the cause. Many theories were advanced, but finally we arrived at the conclusion that contraction of the guide frame had been the cause of the trouble. This was corroborated by the fact that on each occasion there had been unusually low temperature conditions in the engine room. In one instance a window had been left open in the vicinity of the guides, allowing the cold night air to blow in on them.

The crosshead shoes in a compressor of this size, if

pounding is to be avoided, must be adjusted much more closely than in an ordinary mill-type engine, because during the early part of the stroke the steam piston is giving energy to the flywheel and during the latter part the flywheel is giving it out to the air piston, causing a reversal of the forces in the connecting and piston rods and changing the guide pressure from the



VIEW OF COMPRESSOR SHOWING POINT AT WHICH CROSSHEAD SEIZED

lower to the upper guide at a little beyond half-stroke. Consequently, when the guide frame was chilled and the crosshead itself kept warm by the heat conducted along the rod, the contraction was sufficient to pinch the crosshead and cause sudden seizure. On testing the bore it was found that the guides were 0.017 in. wider at the crank end than at the head end, and the shoes had practically no clearance at the narrowest part.

Since then we have adjusted the shoes to 0.002-in. clearance at the narrowest point of the guides, and this seems to have overcome the trouble.

Michel, B. C. THOMAS C. PORTEOUS.

Emergency Limit on an Elevator

One of our elevator machines was of a type similar to that shown in the figure and was originally driven from a lineshaft by a straight and a crossed belt, which ran on the two loose pulleys *A* and *B*. By the belt-shifting device operated from shipper wheel *S*, either one of the belts could be run onto the tight pulley *C*

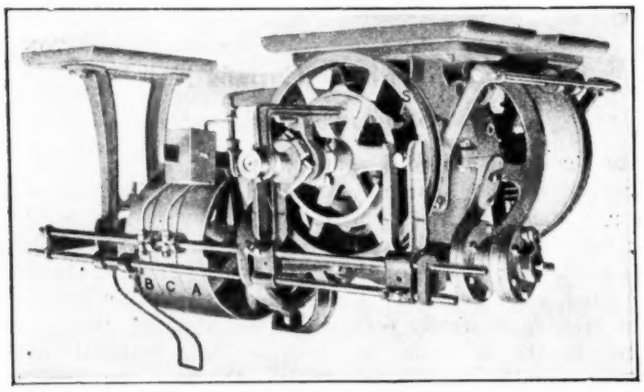


FIG. 1—BELT-DRIVEN ELEVATOR MACHINE

and the elevator driven in a direction corresponding to the belt.

The drive on this machine was changed to an electric motor, belted to the tight pulley *C* and the motor's reversing switch was connected to the shipper wheel through a chain and sprocket wheel. To limit the throw of the shipper wheel, the belt-shifting mechanism was retained. One day this got caught and was broken off, and it looked as though the old machine was out of business for a while. But after clearing away the wreckage, it was found that the only thing needed was something to limit the throw of the shipper wheel so that the operator could not pull the operating cable too far. This problem was solved by connecting the two sides of the sprocket chain, from the shipper wheel to the reversing switch, together with another piece of chain, as in Fig. 2. By adjusting this piece of chain

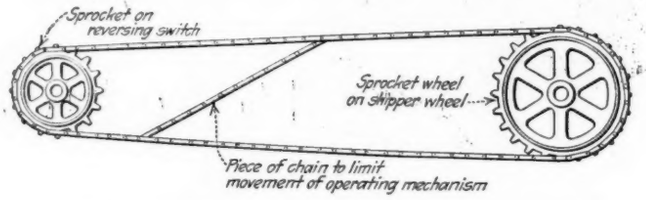


FIG. 2—TWO SIDES OF SPROCKET CHAIN WERE CONNECTED TOGETHER TO LIMIT THE MOVEMENT OF THE OPERATING MECHANISM

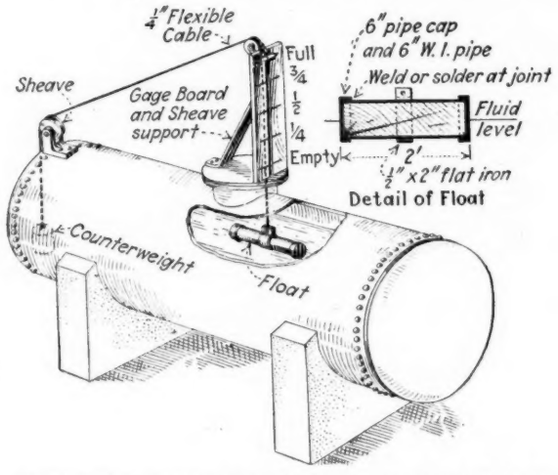
to the proper length, it was possible to adjust the movement of the operating mechanism to the correct amount and the elevator was back into service in a short time.

Springfield, Mass. THOMAS SHEEHAN.

A Positive Float for Oil-Storage Tanks

The floats used in connection with sight gages on fuel oil, tar or gasoline tanks are usually made of copper or sheet-iron cans, which, being very light, do not always rise and fall with the liquid. Therefore one is always in doubt as to the correct level of one's oil supply.

The float shown herewith is heavy and is positive in its action. It is made of a piece of 6-in. wrought-iron pipe which in turn is filled with a piece of wood turned



WEIGHTED FLOAT INSTALLED ON CYLINDRICAL STORAGE TANK

to the proper diameter. The ends are then made tight by using standard pipe caps and either welding or soldering around at the edge of the cap. The counterweight is of cast iron with an eye tapped in and connected to the float with light ¼-in. flexible cable. To arrive at the weight of the counterweight, first determine the weight of the float, then assuming that the float is to be submerged to the center of the pipe, the counterweight will weigh one-half the weight of the float. If friction is excessive at the sheaves, the counterweight must be heavier. If the float is constructed and installed properly, it will be reliable in any location.

Buffalo, N. Y. F. M. COAKLEY.

Comments from Readers

"Anybody Can Run Our Engines"

J. H. Bender mentions the typical salesman's talking point in his contribution on page 571 of *Power*, April 10, dealing with the advantages of having competent operators for oil engines. The salesman who uses this phrase also talks a good deal about his engines being "foolproof," and the use of these expressions has been the cause directly and indirectly of numerous accidents involving loss of life, several of which have come under my personal knowledge. No engine whatever is manufactured that can be brought under either category, and no practical man would be taken in by these remarks, but it often happens that the purchaser has no mechanical knowledge and is out of reach of the influence of *Power*, which is always pressing this point of safety.

Many of us will, I think, admit that in numerous cases anybody with sense enough to shut a valve can stand by an engine that is running very sweetly, and if the duty ended there, we would have little to complain about. Unfortunately, engines and all other machinery are liable to go awry at times, and it is after the "anybody" has closed the valve that real danger develops. He starts in to put things right; quite possibly locates a minor trouble, when it would be much better if he had not, as it is likely to create a false confidence in his ability to do all things.

A few days ago a case of this sort came to my notice. I was asked by a friend who runs a small plant to call around in the evening, and as I was unaware of his trouble, I did not dress for the part, but arranged my evening walk to go by his place. On my arrival I found he had been stuck up all day, a very necessary circulating pump refusing all the persuasion of his clever "anybody" to function. Nothing whatever had been done to it I was assured over and over again. As the pump was below the water level of the feed tank, I told his man to slack off the nuts on the suction-valve cover. To my surprise no water appeared, but it localized the trouble. It must be between the water tank and the valve. Perhaps the valve was stuck, so the man was instructed to remove the cover entirely. Nothing was wrong with the valve and no water was in sight, so I pushed down my stick and found that it stopped at the bottom of the pump where the inlet pipe connected.

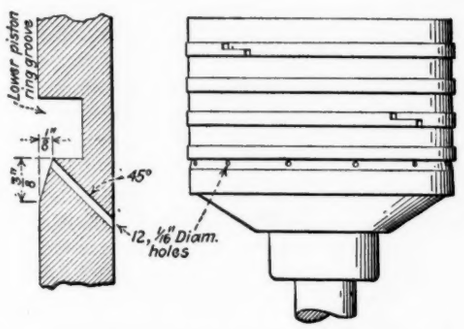
I instructed Mr. "Anybody" to return the suction valve and cover, and then told him to slack back the nuts on the flange of the connection pipe and pump. Water appeared immediately below the rubber joint, and it was some time before he would admit that he had put in a new joint the night before, as the old one leaked a bit and made a mess on the floor. Even then he swore he had cut it just like the old one. He had, except that he forgot to remove the center, a mistake a skilled man might make but would have discovered the error immediately.

The story is only one of hundreds that occur but are never heard of, even by the owner himself, as no accidents happen, consequently the heavy costs cannot be accurately gaged as a set-off against the so-called saving in the wages of the cheap man. There are many influences at work to change this state of affairs, and any suggestion that helps is much appreciated by the men who understand the necessity. F. P. TERRY.

Belfast, Ireland.

How Trouble from Oil in Refrigerating Coil Was Overcome

In the Oct. 11, 1921, issue of *Power*, the writer described the difficulty experienced in a small refrigerating plant due to oil collecting in the brine-tank expansion coils. The compressor is a vertical, two-cylinder single-acting inclosed-crankcase type. The crankcase being partly filled with oil, lubrication of the cylinders and bearings is provided by the splash system. Approximately a barrel of oil a year was being used, and as



SHOWS ALTERATIONS MADE TO COMPRESSOR PISTON

the oil trap was small, a large part of the oil was going over into the system. After the system was cleaned, it was decided to prevent a recurrence of the trouble.

The pistons were removed and placed in a lathe and machined as shown in the illustration. Starting at the lower side of the bottom piston ring groove, a cut $\frac{1}{8}$-in. deep at the groove and tapering for $\frac{3}{8}$-in. to nothing was taken. Then at a 45-deg. angle twelve $\frac{1}{16}$-in. holes spaced equal distances were drilled from the upper edge of the cut through the skirt of the piston. The idea is that the sharp edge of the lower piston ring will scrape most of the excess oil from the cylinder walls, the holes being provided for bleeding the oil to the crankcase again.

A year after the change, the compressor was taken down for its annual overhauling. The cylinders were found in practically the same condition as upon the last inspection, and all bearings were in excellent condition. The oil was not changed during the year and none was added. The oil level in the gage glass had fallen approximately $\frac{1}{2}$ in. during the year, thus showing a consumption of not over two gallons for the year. Needless to say, the entire system gave better service.

Norwalk, Calif. A. C. MCHUGH.

Why Does High Compression Stop the Knock?

Referring to the inquiry of Charles M. Smith in the April 17 issue, "Why Does High Compression Stop The Knock," his letter does not state whether or not the engine is working against back pressure, but I conclude that it is. This being the case, the knock is undoubtedly caused from expanding the steam in the cylinder below the pressure of the exhaust, which causes the valves to lift at the end of the stroke.

There is also the possibility that the steam pressure is too high to give good operating results if only a light load is carried on the engine. Lowering the steam pressure and thereby obtaining a longer cutoff may eliminate his trouble.

FOREST R. BURGOON.

McComb, Ohio.

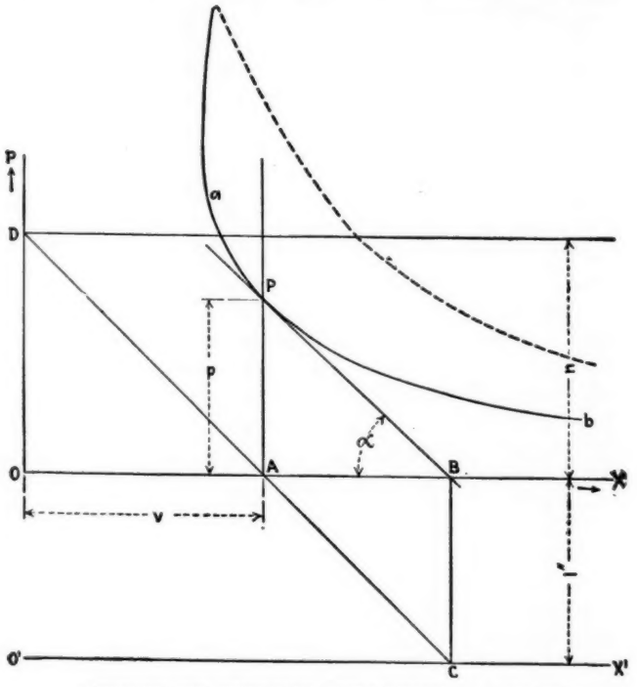
Oil-Engine Indicator Diagrams

The April 10 and 24 issues of *Power* contain discussions by P. H. Schweitzer, covering "A Practical Way to Study Engine Performance." The graphical method shown is new to me. It is clever, theoretically correct, and it permits a quick determination of the exponent n, with a fair degree of accuracy. However, there is one thing which I fail to find in Mr. Schweitzer's article. This is the limitation of exactness of the whole method of analyzing the progress of combustion and the heat exchange between the cylinder wall and the cylinder contents during the compression and expansion strokes.

It was well known that the exponent n is not constant, but varies greatly during the expansion and compression stroke. The fact that the variation of the exponent n was not used more frequently in practice to analyze the performance of the engine was probably due to two reasons: First, the result obtained in this way depends entirely on the correctness of the indicator diagrams used; second, it took too much time to determine the exponent n by calculation. Here Mr. Schweitzer deserves credit for having shown a convenient and rapid graphical method of finding the exponent. However, it is only fair to say that the exactness of this method is quite limited, as it is difficult to draw a true tangent to a curve. The degree of accuracy of this performance determines the exactness of the exponent n.

Referring, for instance, to Fig. 5 on page 554, of the April 10 issue here reproduced, the exponent n is OD, or approximately 1.3, if BC is one inch. The exactness of this exponent 1.3 depends on whether or not the line PB is a true tangent to the curve at the point P. Different persons would draw different lines, imagining that it is the tangent. For instance, I would have drawn the line PB somewhat steeper and would have obtained the exponent $n = 1.45$ and not 1.3. The possibility of error in the method described is greater the nearer point P is located towards the end of the diagram. All research work has a certain degree of accuracy, and when showing a method of investigation, it is always well to state the exactness that may be expected. Unless an investigation can be made within certain limits of accuracy, it will have little or no practical value and it may even be misleading.

The greatest source of possible error is, after all, not in the method of determining the exponent n, but in the indicator diagram itself. Unless the investigator knows that the diagram, serving as the basis of investigations is taken with the greatest care, it is not worth while spending the time to determine the exponent n in order to analyze the diagram; it would even be absurd to draw any conclusion relative to the performance of the engine. Anyone who has used an indicator knows, or should know, that unless he is very careful, the diagrams may have almost any shape. The cord driving the indicator drum may stretch too much and should be replaced by a wire. The indicator itself may not be fastened sufficiently rigid to the engine; that is, when pulling on the cord the indicator may sway back and forth. The pencil of the indicator may be pressed too tightly against the paper. The indicator piping or cock may be obstructed and should have been blown



METHOD OF FINDING EXPONENT OF CURVE

out before the diagram was taken. The indicator piston may not be lubricated properly or not fit into the barrel as it should. The fault may not even be in the manner in which the diagram was taken, but it may be that it was taken at an improper time. When the load changes, the heat conditions inside the engine change. Unless the engine had been carrying the same load for a considerable time, the diagram should not be used. Assuming that the engine was carrying a heavy load for a long period of time, and that a diagram was taken soon after the load dropped off, then the heat conditions of the engine did not correspond to the load when the diagram was taken. The latter would then be misleading. Further, it is of the greatest importance that the line OD be in its proper place. This necessitates an exact knowledge of the combustion-chamber volume. To assume this volume is not sufficient—it must be actually known. If the investigator is conscientious, he will personally check up the piston clearance or combustion space. The latter may vary considerably from the supposed volume. The piston rings, valves, etc., must be tight when the diagrams are taken.

The reader will readily see that there are many possible sources of errors when he tries to criticize an internal-combustion engine by the variation of the

exponent n. Not only one, but several diagrams of each cylinder should be analyzed, and the investigator should be very careful when drawing his conclusions, otherwise he is likely to make ridiculous statements relative to the engine he investigates.

The article mentioned does not state whether the diagrams shown were taken under Mr. Schweitzer's own supervision or that he has positive knowledge that these diagrams were taken at the proper time and manner as would be required for research work. If this is not the case, his whole analysis would be of no value, but misleading; in fact, it would be unfair to make any criticism of the various engines at all. MAX WOLF.

Frankfort, Ind.

What Causes Tubes To Blister With Oil Burning?

In the March 27 issue Mr. Hill asks what causes tubes to blister with oil burning.

My experience with similar trouble leads me to believe that it is due either to dirty tubes or to incomplete combustion before the gases strike the tubes, and possibly both. The trouble I refer to was in a plant containing 6,000-sq.ft. horizontal water-tube boilers with front-shot oil burners and 3,500-sq.ft. Stirling-type boilers with backshot oil burners. As soon as the boilers were changed from coal to oil fired, serious tube trouble developed on the larger units; about thirty tubes per boiler were lost in a month when operating at normal rating. There was little trouble on the Stirling boilers, as they had a large furnace volume and a long gas travel in which to complete combustion before coming in contact with the boiler tubes. After the following changes were made, the trouble on the larger boilers was entirely eliminated.

The tubes were thoroughly cleaned, and suitable equipment was provided to treat the boiler-feed water. The burners were moved to a different position, and changes were made in the checkerwork.

I would suggest that Mr. Hill make sure that his boiler is perfectly clean. Some changes in the checkerwork should be tried. By extending the air openings farther back into the furnace the flame can be made to turn up, or by having them extended back a shorter distance the flame can be made to hug more closely to the floor. The latter condition should give the gases a whirling effect and tend to improve the combustion.

A back-shot burner arrangement should be tried. This would cause the gases to travel a greater distance before coming in contact with the tubes, give a better mixture with the air and result in better combustion. Also extending the Dutch oven out in front of the boiler in order to get the burner farther away should materially lessen the trouble from blistered tubes.

Philadelphia, Pa. S. THOMAS.

Mr. Hill does not give any information relative to the water used in the boiler, and with the assumption that the water is good—that is, that it does not contain scale-forming impurities—I would offer the following solution to the problem:

Increase the flame travel of the present oil burner by introducing the burner in the front wall of the furnace approximately five feet above the floor, set so that it will throw its flame downward on an angle directed at the furnace floor, the air for the combustion to be supplied through brick checkerwork built up across the lower front part of the furnace at an angle corresponding to the angle of the flame travel. The blistering of tubes may possibly be eliminated by other means, such as increasing the depth of the Dutch-oven furnace, increasing the number of burners, thus throwing a smaller load on each burner and spreading the flame furnished by each burner, or firing from the sides of the furnace if its width is adequate. In any event it seems to me that 110 lb. pressure of the oil at the burner is high and that better results could be obtained if this pressure were considerably reduced. C. L. BUTLER.

New York City.

Form of Pump-Valve Springs

I was interested in the inquiry in the May 8 issue as to the relative advantages of conical and cylindrical springs, and I believe your reply may leave the impression that the cylindrical spring is always preferred construction.

My observations, during some sixteen years in the manufacture of all types of pumps and pump valves for all services, indicate that there is generally little or no practical advantage of one type of spring over another. The advantages of simpler valve-stem construction of the conical type are inconsequential in practice, and likewise the advantages of higher lift.

It may not be amiss to say just a word about valve lift and valve area. The requirements for both are much less than generally demanded by engineers. Frequently, the operation and volumetric efficiency are improved by reducing the valve lift, especially the discharge-valve lift. Reducing the lift reduces the time for the valve to close and hence the slippage. The reduction of discharge-valve lift frequently reduces or eliminates the noise of an elevator pump and is a kink often employed by the pump doctor.

It is an unchallenged fact that "the conical form is defective in that the upper coils are stiffer than the others" and break more frequently. This stiffness of the upper coils is of considerable theoretical and practical advantage, especially on vacuum pumps. It is desirable to keep the valve lift to a minimum to reduce slippage, and to close the valve quickly, also to allow the valve to open with as little resistance as possible.

The initial resistance of a conical valve spring, when the valve begins to open, is theoretically very slight but ever increasing until the valve is full open, in which position the conical spring has more power than a cylindrical spring or the valve has a smaller lift and thus closes quicker. The valve should be stopped in its lift by the spring, rather than by striking the valve guard and by repeated blows, breaking the valve guard or valve stem. For practical reasons, it is frequently desirable to limit the lift of the valve by letting it strike the guard, and in such cases the parts will, of course, be made heavy to avoid frequent breakage.

In conclusion, for most general-service pumps a cylindrical spring is usually adopted, perhaps, as stated, because it is less liable to break or it is cheaper, and requires less equipment to make. Springs properly designed and made of good wire will last almost indefinitely, whether conical or cylindrical. There is, however, great difficulty in obtaining a good quality of spring wire. A coil may be first quality at one end and very poor at the other, and no one the wiser till purchasers report breakages. ROBERT E. NEWCOMB.

Holyoke, Mass.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Relative Discharge Through Sticking Check Valve

If two connected boilers are supplied by the same feed pump and one boiler has a sticking check valve, which boiler will receive the greater amount of feed water; and which if the imperfectly operating check valve is removed? C. M.

If there is the same size and length of feed pipe, the same number, kind and sizes of fittings from the pump to each boiler and the water level in each boiler is at the same elevation, the boiler whose check valve sticks against opening as quickly and as wide as the other will receive less water. But if the sticking valve is jammed open wider than the other or the valve is removed from the bonnet, its boiler will receive more water than the other boiler.

Air and Piping Required for Deep-Well Air Lift

What should be the size of air and discharge pipes for an air lift in a 500-ft. well having 8-in. diameter casing, where the pumping head is 65 ft. measured to the surface of the ground and the vertical lift 10 ft. above ground; and what quantity and pressure of compressed air would be required to lift 250 gal. of water per minute? G. B.

Allowing that 0.6 of the air pipe is submerged, reckoning from the elevation of the point of discharge, the depth of submergence would be $(65 + 10) \div \frac{3}{5} = 112.5$ ft. and the length of air line from the ground surface to the lower end of the air line would be $112.5 + 65 = 177.5$ ft. The operating pressure, neglecting the slight reduction due to velocity of water, would be $112.5 \times 0.434 = 48.8$ lb. per sq.in. The number of cubic feet of free air necessary may be computed from the empirical formula,

$$V = \frac{h}{C \log \frac{H + 34}{34}}$$

where V = Cubic feet of free air per minute per gallon of water;
h = Actual pumping head in feet = $65 + 10 = 75$ ft.;
C = A constant, which for the conditions would be about 233;
H = Submergence = 112.5 ft.

Substituting these values, the formula gives

$$V = \frac{75}{233 \log \frac{112.5 + 34}{34}}$$

or $V = 0.51$ cu.ft. of free air per minute per gallon of water, and the free-air capacity required for the air lift would be $0.51 \times 250 = 127.5$ cu.ft. per minute. A 1½-in. air line should be sufficient placed inside of a 5-in. discharge pipe.

The length of discharge line extended from the elevation of the discharge, 10 ft. above the ground, to the air outlet would be $177.5 + 10 = 187.5$ ft., and to the bottom of the discharge line there should be added about 20 ft. of straight pipe having a bell shaped mouth to reduce the entrance losses of the water.

Boiler Capacity Limited by Stack Size

We have a 60-in. diameter by 16-ft. return-tubular boiler with 72 three-inch tubes, 5x5-ft. grate and stack 27 in. in diameter. The boiler capacity is greater when wood is used for fuel. Would it not be practical to increase the grate area for obtaining more boiler capacity when coal is burned? L. M. H.

It would not be practical to increase the present 5x5-ft. grate area as, without a forced or induced draft, the present 27-in. stack would not afford sufficient natural draft for burning more coal to advantage of greater boiler capacity or economy. The reason that more steaming capacity may be obtained of the boiler when burning wood than when burning coal is that when burning wood there is freer air supply and better draft. When burning coal, a considerable part of the draft pressure is used to force the air supply through the partly obstructed grate openings and fuel bed, whereas when burning wood there is little obstruction of the grate openings and much freer passage for the draft through the fuel. Draft conditions would be more nearly the same if the wood burning had to be performed on top of a bed of dead coal spread over the grates to the usual depth of a coal fire. In that case less boiler capacity could be developed than when burning coal.

Current Waterwheels

What number of horsepower should be developed by a current waterwheel 10 ft. diameter with floats 15 ft. long by 3 ft. 6 in. deep, where the velocity of the current is 5 ft. per second; what number of floats should be used and what should be the number of r.p.m. for best effect? M. E.

Wheels of this class usually are provided with at least six equally spaced plain and radial floats with a radial breadth equal to one-fourth the diameter of the wheel, thereby requiring a 10-ft. diameter wheel to have floats of radial breadth of 30 in.; or, if the location warrants a breadth of 3 ft. 6 in., for best results the wheel diameter should be 14 feet.

If the velocity of the center of the float is one-half the velocity of the current, the efficiency should be 40 per cent of the energy of the water intercepted by a

float. With a current flowing at the rate of 5 ft. per second the head equal to that velocity would be $(5)^2 \div 2g$, or $\frac{25}{64.3}$ ft.; the quantity of water presented per square foot per second would be 5 cu.ft., or $5 \times 62.3 = 311.5$ lb.; the energy per square foot of cross-section of the intercepted current would be $\frac{25}{64.3} \times 311.5 = 121.1$ ft.-lb. per sec., or $121.1 \div 550 = 0.22$ hp.; and with 40 per cent efficiency, the power developed by the wheel would be $0.22 \times 0.4 = 0.088$ hp. per sq.ft. of cross-section of intercepted current. Hence, with a wheel 10 ft. diameter having floats 2 ft. 6 in. wide, the wheel should run $(5 \times 60) \div [(10 - 2.5)\ 3.1416] = 12.73$, or practically 13 r.p.m., and with floats 15 ft. long the power realized should be $2.5 \times 15 \times 0.088 = 3.3$ hp.

With a wheel 14 ft. diameter having floats 3 ft. 6 in. wide, the wheel should run $(5 \times 60) \div [(14 - 3.5)\ 3.1416] = 9.09$ r.p.m. and with floats 15 ft. long, the power realized should be $3.5 \times 15 \times 0.088 = 4.62$ hp.

Provision should be made for supporting the wheel at such elevation that when in lowest position a float will be no more than completely submerged. Means should be employed for controlling the height of the water or for regulating the elevation of the wheel. On account of the cost of construction and maintenance as compared with the power realized, waterwheels of this type are rarely employed except when carried by boats moved in a rapid current.

Separating Water from Heavy Oil

We are having considerable trouble to completely separate water from a heavy oil to prevent emulsification after the oil has been passed through a centrifugal separator. How can the separation be performed more completely? W. L. M.

The separation is difficult because the specific gravity of the oil is so nearly the same as that of the water. By adding a sufficient quantity of salt to the oil, the specific gravity of the water content may be increased sufficiently above that of the oil to effect centrifugal separation.

Adjustment of Quarter-Boxes

When adjusting main bearings on a horizontal engine, should there be any clearance between the cap and quarter-boxes when the cap is seated square on the housing; or should the cap rest gently on the quarter-boxes to allow for adjustment of the wedge? Also, are all quarter-box wedges moved toward the bottom box for taking up the slack in the quarter-box adjustment? If the cap rests in the quarter-box, how is the adjustment made of the cap? G. L. M.

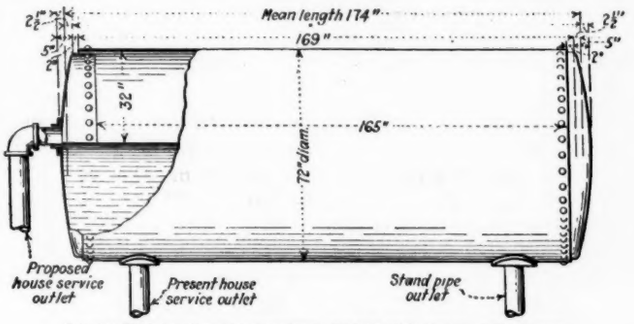
The function of the quarter-boxes is to hold the journal in position laterally, and for that purpose a quarter-box should adapt itself to the level of the journal, which is determined by the height of the bottom box, and not be held independently in a rigid vertical position, and that vertical clearance also will permit adjustment of the wedge when the cap is set down on the housing. Otherwise, unless all fitting and adjustments have been made with great skill, the bearing is likely to pound or become overheated.

Some quarter-box wedges are made to be moved away from the cap for taking up the quarter-box, thereby bringing vertical pressure of the quarter-box against the bottom box; others are provided with wedges which are drawn toward the cap, tending to lift the quarter-box against the under side of the cap.

If the cap rests on the quarter-boxes, its adjustment is limited by the height of the quarter-boxes, and to effect closer adjustment of the cap, it is necessary to remove material from the top of the quarter-boxes and use appropriate shimming under the flanges of the cap so that the quarter-boxes will be just clear of the cap when the latter is firmly set in place.

Location of Tank Connection To Insure Stated Reserve Capacity

We have a house-service water tank 72 in. in diameter, with sides 165 in. long and bumped heads of dimensions shown in the sketch. At present the house service is drawn from the bottom of the tank. The fire department requires a reserve of 1,750 gal. for



LOCATION OF SERVICE OUTLET FOR STATED STANDPIPE RESERVE

standpipes, so that it becomes necessary to connect the house service at a point that will leave that quantity of water in the tank. How high should the house service be connected for that purpose? W. H. W.

Taking all dimensions as inside measurements, the cross-sectional area of the tank would be $72 \times 72 \times 0.7854 = 4{,}071.5$ sq.in. The length of the cylindrical portion of the shell, including the flanging of the heads as shown in the sketch, would be 169 in. For practical purposes the mean height of the bumped heads may be taken and the volume of content computed on the assumption of having a cylindrical tank with flat heads and length equal to the mean length of 174 in. On this assumption the tank, when filled, would hold $4{,}071.5 \times 174 \div 231 = 3{,}066.8$ gal., and to leave a reserve of 1,750 gal., there could be $3{,}066.8 \div 750 = 1{,}316.8$ gal. drawn from the full tank. The quantity so drawn would be $1{,}316.8 \div 3{,}066.8 = 0.4293$, or 42.93 per cent of the full tank capacity, and the cross-sectional area of the space above the reserve would be that same percentage of the cross-sectional area of the tank.

With a diameter of 1 in., the area would be 0.7854 sq.in. and 42.93 per cent of that area would be 0.33717 sq.in. Referring to a table of areas of segments of a circle with diameter of 1, it may be found that the area 0.33717 corresponds very nearly to the height 0.444; that is to say, when the area of the segment is 42.93 per cent of the whole cross-sectional area of a circular tank, the height of segment is 44.4 per cent of the diameter. Hence, to draw no more than 42.93 per cent and leave 1,750 gal. in the tank, the lowest part of the house connection should be 44.4 per cent of 72 in. = 31.96, or practically 32 in. from the top of the tank.

Easy Lessons in Engineering

Force, Work, Energy and Power

This article will explain briefly the meaning of the fundamental ideas of force, work, energy and power as used in engineering. First, a *force* is a push or pull and is ordinarily measured in pounds by American engineers. A force may or may not do *work*. If the body on which the force acts remains at rest, no work is done. If the body moves, work may or may not be done theoretically. In order that work may be done, all or part of the force must act in the direction of the motion. To lift a 2-lb. weight 5 ft. vertically requires the expenditure of $2 \times 5 = 10$ ft.-lb. (*foot-pounds*) of work, work being the product of the distance moved by the force in the direction of motion.

In this case all the force was in the direction of the motion, so the work was simply the product of the total force times the distance. If a car weighing 40,000 lb. is hauled along a level track a distance of 10 ft., the work is not $40{,}000 \times 10 = 400{,}000$ lb. The force in the direction of the motion is only the friction, which might be, say, 1,000 lb. If that were the case, the work done would be $1{,}000 \times 10 = 10{,}000$ foot-pounds.

Energy is the capacity for doing work and may be measured in the same units as work. If a body, on account of its position, velocity, heat content, chemical composition, etc., has the capacity for doing 18 ft.-lb. of work, it is said to contain 18 ft.-lb. of energy. For example, if a body weighing 3 lb. is suspended 4 ft. above the ground, it contains 12 ft.-lb. of energy in respect to the ground, because if lowered to the ground it could exert a force of 3 lb. through a distance of 4 ft. and thus do $3 \times 4 = 12$ ft.-lb. of work. This energy due to position is called *potential* energy. In the same way a moving mass contains energy (called *kinetic* energy) because it will do work on any body that brings it to rest by opposing it. The energy in any moving body may be figured by the formula,

$$E = \frac{WV^2}{64.4}$$

where E = energy in foot-pounds, W = weight in pounds, and V = velocity in feet per second.

A common application of this formula is to flywheels. In the case of a flywheel the parts are moving at different velocities. If, however, most of the weight is in the rim, and the rim is fairly thin measured along the radius, no great error is introduced by assuming that all the weight is concentrated along a circle in the middle of the rim. As an example, suppose the rim of the wheel weighs 8,000 lb. and that the center point of the rim is moving with a velocity of 80 ft. per sec. Then, assuming that all the weight is concentrated at this radius, the energy contained would be, approximately,

$$E = \frac{8{,}000}{64.4}(80)^2 = \frac{8{,}000 \times 6{,}400}{64.4} = 795{,}000 \text{ ft.-lb.}$$

If a drum and rope were on the same shaft and a weight of 2,000 lb. on the end of the rope, the energy of the flywheel would lift the weight $795{,}000 \div 2{,}000 = 397.5$ ft. before the wheel came to rest.

Heat can be changed into work and vice versa. The unit of heat is the *British thermal unit* (B.t.u.), which is the amount of heat required to raise the temperature of one pound of water one degree F. It has been found that when work is turned into heat, usually by friction, it takes 778 ft.-lb. to make 1 B.t.u.

The same relation holds when heat is turned into work, except that it is impossible to turn all of any given amount of heat into work. For example, a pound of coal burned in a steam power plant may give off 14,000 B.t.u. Perhaps 10 per cent of this, or 1,400 B.t.u., will be delivered as work at the shaft of the prime mover, giving $1{,}400 \times 778 = 1{,}090{,}000$ ft.-lb. approximately. The remaining heat $(14{,}000 - 1{,}400 = 12{,}600$ B.t.u.) disappears up the stack, out the exhaust, as radiation etc.

Electrical energy is measured in *kilowatt-hours* (kw.-hr.). The relation between this and other forms of energy (heat and work) is as follows:

$$1 \textit{ kw.-hr.} = 3{,}415 \textit{ B.t.u.} = 2{,}655{,}000 \textit{ ft.-lb.}$$

From this we see that it would require 2,655,000 ft.-lb. to produce 1 kw.-hr. in a perfect generator. If this were then turned into heat by a resistance the heat produced would be 3,415 B.t.u., enough to raise 34.15 lb. of water 100 deg. F.

We now come to *power*, which differs from work or energy in that the element of time is introduced. A given amount of work can be done by any engine large or small if properly geared, but a large engine will do the work more quickly. It has more *power;* that is, it does more work in a given time. There are many units of power. One is the *foot-pound per second* (ft.-lb. per sec.), that is, work done at the rate of one foot-pound every second. If a hoist raises 500 lb. a distance of 25 ft. in 5 sec., the work done is $500 \times 25 = 12{,}500$ ft.-lb. The power is $12{,}500 \div 5 = 2{,}500$ ft.-lb. per sec. since 2,500 ft.-lb. of work are done in each second.

Two other units of power are the *horsepower* and the *kilowatt*. One horsepower = 550 ft.-lb. per sec., or 33,000 ft.-lb. per min. The horsepower developed by the hoist just mentioned would be $2{,}500 \div 550 = 4.55$ hp.

To take care of friction the horsepower of the motor would have to be a little more than this. The electrical unit of power is the *kilowatt*, which is equal to 1.341 hp. If there were no friction and no motor losses, the motor on this hoist would require $4.55 \div 1.341 = 3.39$ kw. to lift the 500-lb. load at the rate of 5 ft. per sec. To get the actual power required, it would be necessary to take account of the friction and electrical losses, or in other words to take account of the *efficiency*. This question of efficiency will be considered in a later article.

A. S. M. E. Meets with Canadian Engineers

OVER six hundred members and guests of the American Society of Mechanical Engineers met with the local branches of the Engineering Institute of Canada and of the A.S.M.E. last week at the Mount Royal Hotel, Montreal, for the Spring meeting of the Society.

The convention opened Monday morning with a Council meeting, followed in the afternoon by a business meeting and addresses by President Harrington, Secretary Rice and Col. John P. Jackson. Mr. Rice spoke of his trip to South America as a delegate to the Engineering Congress in Rio de Janeiro and urged closer co-operation with the engineers of that continent, especially in the matter of standardization.

Colonel Jackson told of the plan and scope of the Sesquicentennial celebration to be held in Philadelphia in 1926 to commemorate the one hundred and fiftieth anniversary of the signing of the Declaration of Independence. It is to be an exhibition of the progress of the United States in art, science, industry and commerce, in which engineering will claim a prominent part.

In the evening the Council of the Society were guests of the Council of the Engineering Institute of Canada at the St. James Club, during which W. J. Francis, president of the Institute, presented a gold badge to President Harrington.

Canadian Hydro-Electric Developments

At the first Power Session on Tuesday morning two papers were read—the first on "Power Development in the Province of Quebec," by Julian C. Smith, and the second by Frederick A. Gaby, on "The Development of Hydro-Electric Power Plants in Ontario."

Mr. Smith's paper,[1] outlined the potential water powers of the province as divided among the several watersheds. Although a total of 53 millions of continuous horsepower were thus represented, only about 25 per cent of this is capable of commercial development, thus making a maximum of approximately 13 million horsepower. But it would now be economical to develop only 5 million horsepower and of this 800,000 hp. is already being utilized.

The author drew a historical picture of the water-power developments in the province, beginning with the grist mills about 1650, which operated on from 5 to 15 ft. head. The first independent power development was in 1895 and consisted of five 600-hp. units; the latest units installed in 1923 were of 43,000 hp. In 1903 the turbine efficiencies reached 76 per cent, whereas in 1923 the over-all efficiency was over 88 per cent with the curve much flatter. By means of slides the speaker showed the principal plants now in operation. These included Cedar Rapids, of 170,800 hp. capacity; the Laurentide Power Co., with eight 20,000-hp. units operating under 84 ft. head; and the Shawinigan Development, where 195,000 hp. is installed and where two more 43,000-hp. units are to go in. He also spoke of the Quebec Development Co.'s plants on the Saguenay River, the first of which will be ready in two or three years. It will operate under a 300-ft. head and have 400,000 hp. capacity. The second plant will be twice that capacity. Paper mills alone account for 320,000 hp. in the province. The average load factors for several industries were given as 65-75 per cent for paper mills; 85-90 for carbide plants; 80-90 for cement mills and 45 per cent for asbestos and mining.

Mr. Gaby sketched the power system of the Toronto Hydro-Electric Commission, which started in 1910 with an initial investment of three million dollars and has developments now totaling 625,000 hp., which will be increased to 820,000 at an early date. The system serves 350 municipalities and involves over 3,500 miles of transmission lines, of which the longest is 254 miles. The speaker described in some detail the Chippawa-Queenston installation involving ten 60,000-65,000-hp. units operating under a head of approximately 300 ft. at a turbine efficiency of 93 per cent or an over-all plant efficiency of 90 per cent. Of the smaller plants of the system there are thirty, aggregating about 50,000 hp. The ordinary flow of these rivers has now been utilized and all the present plants will be fully loaded by 1926. Therefore, in order to secure additional power the next step is to provide storage reservoirs. On the St. Lawrence there are two more sites that would make possible an additional two million horsepower. The development of one of these, at Cornwall, may be undertaken as soon as conditions warrant. Already $300,000 has been spent by the Commission on investigations of the St. Lawrence. Hydro-electric installations in the Province of Ontario, including those of the Commission, total over 1,300,000 horsepower.

The second Power Session was opened with a paper by H. G. Acres, of Toronto, on "Modern Hydraulic Turbines of Large Capacity." The speaker confined his remarks to units of over 25,000 kw. capacity and over 70 ft. head. One of the principal factors in such installations is the control of surges in long conduits under high head. This imposes a heavy duty on the governor and the valve. The present form of Johnson valve, in the opinion of the speaker, is ideal for the conditions as is also the White Shaft Governor. The governor should control the speed of the generator and not the vagrancies of the water column. A simple standpipe can absorb only part of the surges and is not nearly so effective as the Johnson surge tank. If a turbine is operating beyond the point of best efficiency, it will require an increasing amount of water per kilowatt, and this will impose a greater demand on the gate and the governor.

Mr. Acres then passed to a consideration of bearings and showed the limitations of the pillow block as used on horizontal units, up to 20,000 hp., finally leading up to the Kingsbury type, now used on the larger vertical units. He showed how the labyrinth form of water seal, consisting of contracting and expanding passages, is effective in cutting down leakage, which in large turbines can easily amount to the wastage of a great amount of power. Pitting and erosion of runners can be practically eliminated if the customer is willing to pay the price for the turbine and keep the specific speeds low. Moreover, it is best to operate at the point of best efficiency, as the rate of runner deterioration is least at this load; full gate opening can then be reserved for overload.

Other subjects discussed by the speaker were the Gibson method of measuring the flow and the more recent salt-velocity method devised by Professor Allen. Touching on draft-tube design, he held that the elbow type is entirely inadequate and showed how the Moody and the White designs are effective in avoiding cavitation and turbulence. The large turbines at Queenston, equipped with the latter types, are operating at a maximum efficiency of 93 per cent or 85 per cent at full gate opening, the former figure corresponding to an over-all efficiency at the switchboard of 90.5 per cent.

In discussing the paper, Prof. R. W. Angus expressed the belief that Mr. Acres' remarks could be applied also to medium- and low-head plants and that the form of draft tube is even more important in low-head plants where high specific speeds are employed.

Comparative Tests on Draft Tubes

L. F. Moody agreed with what Mr. Acres had said and pointed out that a difference of one per cent in efficiency of the Queenston units amounted to as much as the entire output of one of the original 5,000-hp. units at Niagara. He gave the results of tests made by Hugh L. Cooper & Co. for the War Department on five different types of draft tubes.[2] The highest efficiency was shown where the central cone was brought up to the runner hub.

W. H. White emphasized that high specific speeds are conducive to pitting. He related how the Swiss designs had been discarded twenty years ago and purely American types had been evolved with much more satisfactory results.

[1] This will appear in a later issue of *Power*.

[2] See *Power* May 29, 1923, for a full report of these tests.

The hydraucone and the spreading draft tube, he contended, give practically the same results.

Professor Allen described his salt-velocity method of measurement, which consists simply of introducing a charge of salt into the intake and inserting two electrodes at convenient points in the pipe. By electrical measurements and a time-recording device the velocity of the water passing the electrodes can be ascertained, and knowing the area of the pipe, the amount of flow can be computed easily. The Gibson method, utilizing momentum, has so far checked very closely with the salt-velocity method. Professor Allen suggested that a Johnson valve could be employed as a first-class venturi meter. This would be very desirable as it is just as important to measure the input continuously as the output.

Control of High-Pressure Steam Lines

Considerable discussion centered around the paper by P. P. Dean, on "Sectionalization and Remote Control of High-Pressure Steam Lines." The paper presented methods that have been adopted by a number of large plants and explained the construction of various protective devices, valves and motor-control systems that are now available. In view of the increase in steam pressures and temperatures now being adopted, the problem assumes added importance. Elaborate precautions are usually taken to safeguard and remotely control the high-voltage electrical equipment, yet it is not uncommon to find control valves for steam placed in the most inaccessible locations. While a start has been made in investigating the effectiveness of certain valves in shutting off steam at high velocity and high pressures, notably the Essex tests,[1] the results have been by no means conclusive and there is need for greater investigation along this line. Mr. Dean showed moving pictures of the Essex tests.

It was the opinion of several who discussed Mr. Dean's paper that it is not so much the effect of pressure difference as of arresting the high velocity of the steam, and it is difficult to shut a gate valve under these conditions without damaging the gate as it comes down into the seat. Where the guides are not machined, a slight cutting by the gate due to the heavy thrust and slight misalignment will greatly increase the friction, and then the trouble begins. With a globe valve the duty imposed on the control mechanism is even more severe. It was the consensus of opinion that a non-return valve should never be used for this purpose, but that it is well to place a remote controlled gate valve beyond the non-return valve. One speaker suggested that the ideal valve for this purpose might be constructed somewhat along the line of the Johnson valve used in hydraulic work.

"Chimney Sizes" were discussed in a paper by Alfred Cotton. This, in the author's absence, was read by E. R. Fish. The paper, which will be abstracted more fully in a later issue of *Power*, was based on the premise that under any specific conditions there is a definite static draft for a given height and a definite maximum capacity for any given diameter. These are connected by a fundamental curve applicable to all chimneys under all conditions. A large number of charts were included giving the static draft and maximum capacity up to 500 ft. in height and 25 ft. diameter from which the working draft and capacity may be found from the fundamental curve. Other charts give factors for various atmospheric conditions, altitudes and approximate work.

In a written discussion Prof. J. C. Smallwood questioned the accuracy of some of the fundamental data used by Mr. Cotton, especially Menzin's coefficient for frictional resistance and the author's estimate of mean temperatures of chimney gases, and cited tests made at Massachusetts Institute of Technology and Johns Hopkins University.

Professor Christie told of the extensive Johns Hopkins tests conducted by Professor Smallwood, but pointed out that the discovery of considerable air infiltration had introduced a compromising factor. In making these tests it had found that the ordinary thermocouple was not reliable, hence a resistence grid was devised that could be placed across the chimney at any height. This gave much better average results as to temperature of the gases. In a study of a number of chimneys in large power plants he had found that most of them conformed very closely to Kent's original formula.

It was suggested by Mr. Uehling that co-operation might be secured between the Government and some of the large power companies with a view to making a thorough study of chimney design and performance.

The final paper of interest to *Power* readers was that on "Lignite Char," by O. P. Hood, of the United States Bureau of Mines. Mr. Hood explained that lignite char is a lignite which has been dried and distilled in an oven especially designed for this purpose. About 2½ tons of raw lignite reduce to one ton of char, the heat value of which is about 12,000 B.t.u. per lb. Unlike the German brown coal the American lignites do not briquet well without the addition of a binder, and the Bureau of Mines has therefore been led to investigate the possibilities of an inexpensive carbonizing process and the use of the resulting char direct without briquetting. A drawing of the machine was shown. No attempt is made to recover the byproducts.

It was pointed out by Mr. Hood that one of the difficulties involved is the fact that most of the lignite holdings are on a small scale such as to make an expensive carbonizing installation unattractive. Moreover, in those localities there is practically no market for the byproducts involved. The idea of the Bureau was therefore to design a cheap process that might supply to the adjacent localities a domestic fuel that would compete successfully with anthracite. The char is comparable with the small sizes of anthracite and would therefore require special grates in the house furnaces.

Max Toltz reviewed the effect of the peace treaty in compelling Germany to a greater utilization of its lignite and brown coals inasmuch as she has lost a large part of her high-grade coal lands and of what is left a large part of the annual production has to be sent to France as part of the indemnity. He told of the stepped grates adopted by the German power plants in order to burn the brown coal.

Mr. Thompson, of the Lignite Utilization Board of Canada, told of the investigations by that body. He did not look upon char as a final product, but is directing his attention to the solution of briquetting, but as yet satisfactory results from a commercial viewpoint had not been attained. The Board is now trying out the carbonizer devised by the United States Bureau of Mines.

Boiler Code and Power Test Codes Hearings

On Monday afternoon at a public hearing opportunity was offered by those interested to suggest revision of the tentative code on Internal Combustion Engines and Chapters 1 and 2 of the Code on Instruments and Apparatus. The formulation of the Codes will proceed in the light of the oral and written discussion developed.

The Boiler Code Committee held public hearings Tuesday afternoon and Wednesday forenoon for the discussion of Proposed Rules for the Care of Steam Boilers in Service and a proposed code for the Inspection of Steam Boilers. Much interest was manifested, and the suggestions involved will be considered by the committees in perfecting their respective codes.

Excursions were made to the Cedar Rapids hydro-electric plant, the Dominion Engineering Works, the Laurentide power house and paper mill and the plants of the Shawingan Water & Power Co. Local trips were also made to McGill University, the various cold-storage plants and breweries, and a boat trip through the Lachine Rapids.

Other entertainment features included a smoker on Tuesday night and a dinner dance at the Mount Royal Hotel on Wednesday evening.

After several days of open session and a final executive session the nominating committee made the following selections for 1924: President, F. R. Low; vice-presidents, George I. Rockwood, M. L. Cooke, W. J. Sando; managers, E. O. Eastwood, F. A. Scott, E. R. Fish; representatives on American Engineering Council, D. S. Kimball, William Schwanhauser, S. W. Stratton, F. F. Walker, F. K Copeland, J. T. Faig, R. E. Flanders, C. C. Thomas, W. B. Powell; treasurer, W. H. Wiley.

Cleveland, Ohio, was selected for the next spring meeting.

[1] Reported in *Power*, Feb. 14, 1922.

New French Station at Comines*

A steam-electric central station of 50,000-kw. present continuous capacity has just been erected at Comines, France, by the Société l'Energie Electrique du Nord de la France. The station is on the River Lys (Belgium frontier), about ten miles from Lille. At present there are three 25,000-kw. generating units, one being a reserve. Later, two more units will be added, raising the continuous capacity to 100,000 kw.

By means of the Lys and railway connections, French, Belgian, German or British coal is readily obtainable. The Lys also makes available a minimum of 4,000,000 gal. of water an hour for condensing and other purposes.

Coal brought by barge or rail is taken by three 80-ton-per-hour traveling transporters (with grab buckets) to storage piles. It then passes to a belt conveyor, provision being made to mix several grades on the belt when desired. The belt passes over an automatic weigher to a crusher, where the coal is reduced to 1-in. cubes. It is then elevated to a tower, from which it is carried by a belt conveyor to the boiler-room hoppers.

The boiler room (205 ft. long) contains ten 10,764-sq.ft. Babcock & Wilcox boilers, each equipped with an economizer and a 5,382-sq.ft. superheater furnishing steam at 300 lb. and 660 to 700 deg. F. total temperature. Eight of the boilers have three Babcock & Wilcox chain-grate stokers each, with a total grate area of 337 sq.ft. per boiler.

The other two boilers are fired with powdered coal, the fuel for each being pulverized by three "aëro pulverizers" with an hourly capacity of 4,400 lb. each. The combustion volume of these boilers is 3,990 cu.ft. The pulverizers feed directly to the boilers and are themselves fed from the overhead bunkers.

There are two motor-driven forced-draft fans, each designed to furnish 1,600,000 cu.ft. of air a minute at a static pressure of 3½ in. of water. The chimneys are of the "Louis-Prat" type with induced draft (two 20-hp. fans per chimney).

The turbine room (210 x 80 ft.) contains three 25,000-kw. generating units (one a reserve), with space for two more. Each unit is driven by a Schneider-Zoelly ten-stage impulse turbine running at 1,500 r.p.m. and taking steam at 256 lb. and 660 deg. F. The generators are three-phase 50-cycle 10,500-volt, with direct-connected exciters.

A 3,500-kw. house turbine (Rateau, 3,000 r.p.m.) supplies the motor-driven auxiliaries and station service. Current is generated at 10,500 volts, and most of it is transformed to 220 volts for auxiliary drive, but some is specially transformed and then is converted for use in special direct-current motors. The auxiliary busbars can also be supplied from the main generators in case of accident to the house turbine. A second house turbine (5,200 kw.) will be installed eventually.

The boilers are fed on the closed-circuit system, the raw makeup water from the Lys being chemically purified before being used. The chemical purifier is provided with a large storage tank to permit 8-hour operation. There are four 33,000-gal. per hour feed pumps, three being turbine-driven and one motor-driven.

The steam piping is of solid-drawn mild steel and is insulated with 85-per cent magnesia 3½ in. thick. Steam-flow meters are used.

There are four motor-driven circulating pumps. When the capacity of the station is raised to 100,000 kw., the Lys will not supply sufficient cooling water at periods of low water, so cooling towers will be erected to take care of the difference.

An article in the March issue of *The Valve World* comments on the superiority of basic electric cast steel. Recent experiments have shown that this steel, which has a tensile strength of 75,000 lb. per square inch at 600 deg., still retains 37,000 lb. at 1,000 deg. Moreover, the yield holds up even better than this, being 35,000 lb. at 600 deg. and 25,000 lb. at 1,000 deg.

*Abstract of articles in the March 9 and March 16 issues of *Engineering* (London).

Design of Furnaces for Burning Powdered Coal

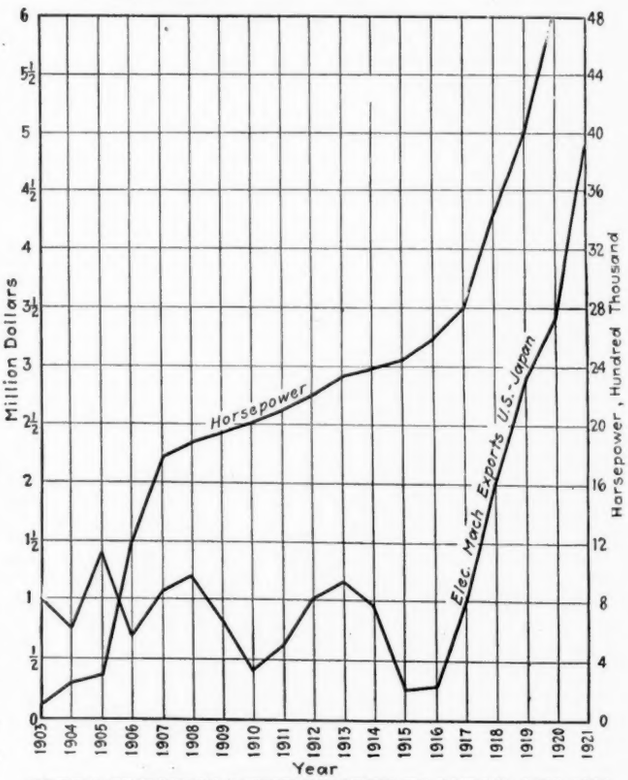
Furnaces in which powdered coal is to burn must be large enough and be correctly shaped, so that the coal may burn completely without impinging on the brickwork, and must be provided with facilities for removing the ash, states the Department of the Interior in Bulletin 217, just published by the Bureau of Mines. If the furnace is correctly designed about 3 B.t.u. per second may be liberated per cubic foot of combustion space. This rate of combustion is sometimes exceeded, but if it is much exceeded the coal will not be burned completely.

In many furnaces the temperature is so high that the ash fuses, and, on settling in the furnace, collects in a continuous mass. It has become expedient in some furnaces to cook the ash before settling and so prevent its collecting in a continuous mass, though generally this is not done, and the ash collects either on the hearth, whence it is removed when the furnace shuts down, or it is removed as a liquid slag. The ash that does not settle in the furnace goes off with the gases, and care must be taken to see that it may not be deposited in the flues and so impede the draft.

When a furnace, previously heated by coal burned on a grate, gas or oil, is to be transformed into a powdered-coal fired furnace, the furnace may or may not have to be modified in design to suit powdered coal. Except for boiler furnaces very radical alteration of design is unusual. At most, the change consists usually in enlarging the furnace. But no furnace should be fired with powdered coal without the advice of experienced engineers, who will either approve the application of powdered coal to the furnace as it exists or carefully redesign it so that it may be economically operated with powdered coal, using the best means of disposing of the ash.

Exporting Electrical Equipment to Japan

Since the war there has been an extraordinary increase of hydro-electric development in Japan, and it has been coincident with a similar great increase in American exports of electrical equipment to Japan. This is shown graphically in the accompanying chart.



HYDRO-ELECTRIC DEVELOPMENT IN JAPAN, 1903-1921

News in the Field of Power

New Reservoir May Affect Developments on Delaware

The Pennsylvania Power & Light Co., a subsidiary of the Electric Bond & Share Co., has filed a declaration of intention with the Federal Power Commission, covering a large project in the vicinity of Scranton, where it is proposed to construct a reservoir storing 9,000,000,000 cu.ft. of water. It is intended to develop 47,000 kw. in the Wallenpaupack River. This reservoir will have an important bearing on the development of the Delaware River. Plans being considered for the development of this latter river call for the ultimate harnessing of 450,000 hp. between Hancock, N. Y., and Belvedere, N. J.

Flathead River and Flaming Gorge Projects Deferred

Action was suspended on the application of the Rocky Mountain Power Co. for a permit for a project on Flathead River below the outlet of Flathead Lake, involving the development of 270,000 hp., in order to await the conclusion of the investigation of the Columbia Basin Project, which is being undertaken by a commission consisting of Assistant Secretary of the Interior Goodwin and Director Davis of the United States Reclamation Service, appointed by the Secretary of the Interior, pursuant to recent legislation.

In view of its decision to defer for the present consideration of all applications affecting the Colorado River, the Commission suspended action on the application of the Utah Light & Power Co. for a power project to be located on Green River at Flaming Gorge in northern Utah, and also on the application of James B. Girand for a license for his project on Diamond Creek, in Arizona.

Progress of the High Dam Project

The formal application, accompanied by the details of the plans of the Ford Motor Co. for a license covering the High Dam project at St. Paul, was filed with the Federal Power Commission on May 22, by J. H. Manning, the managing engineer for Stone & Webster. The plans are now being submitted to the District Engineer of the War Department at St. Paul and the Division Engineer at St. Louis. The plans of the Ford Company include a steam plant, which will probably be erected as a part of the hydro-plant building but with a party wall between. The value of the structures on which Mr. Ford must pay interest has been fixed at $1,200,000.

Chemical Industries Will Hold National Exposition

The chemical industry is to hold a big chemical exposition, at the Grand Central Palace in New York City, from September 17 to 22. The chemical, dyestuff and medicinal industries, chemical-equipment industry, laboratory-supply manufacturers and allied industries are to be participants. Group conferences will be held, and a series of lectures for students of chemical engineering, without cost to the student, has been planned.

Bolivian Volcano To Run Railway Lines

A concession to make use for power purposes of the hot steam and gases emitted by the Tatic volcano has been granted to Sr. Luis Torti, the Pan-American Union has been informed. The volcano is in the Canton of Sud Lipez, near the Chilean frontier. According to Sr. Torti about 50,000 hp. should be available, as the vapor contains very little carbonic acid and can be immediately transported to the turbines.

Existing conditions in Germany are forcing out of business the coal-burning power plants with high operating costs, according to a report received by the Department of Commerce. Such stations have had great difficulty in securing the necessary credits for extensions and new equipment. Difficulties in the procurement of coal have added to their troubles. The result has been a further concentration of power production in the larger and more efficient stations. This is stimulating interconnection and as a result lower rates to consumers have been made possible. A very lively interest is being manifested at this time in the conversion of some of the larger central stations from steam produced power to water power. The negotiations have progressed to the point where steps now are being taken to provide the necessary financing. The matter has been taken up with both German and foreign bankers. Because of the very large amounts involved no great amount of encouragement has been forthcoming.

A.I.E.E. Program for Swampscott

The program of the annual convention at Swampscott of the A.I.E.E. will contain the following papers and reports that will be of interest to readers of *Power*:

TUESDAY, JUNE 26, 10 A.M.

Address of welcome by Governor Cox of Massachusetts.

Address by President Jewett.

WEDNESDAY, JUNE 27, 10 A.M.

"Weymouth Power Station," by I. E. Moultrop, Edison Elec. Ill. Co. and J. Pope, Stone & Webster.

"Cooling of Electric Machines," by G. E. Luke, Westinghouse Elec. & Mfg. Co.

"Free and Forced Convection of Heat in Gases and Liquids," by C. W. Rice, General Electric Co.

WEDNESDAY EVENING, JUNE 27, 8 P.M.

Brief review of progress during the year, by the chairmen of several technical committees.

FRIDAY, JUNE 29, 10 A.M.

"Quality of Incandescent Lamps," by J. W. Howell and Henry Schroeder, Lamp Works, General Electric Co.

"The Art of Sealing Base Metal Through Glass," by W. G. Housekeeper, Western Electric Co.

"Measuring Instruments Standards," by H. B. Brooks, Bureau of Standards.

"Continuous Current Generator for High Voltage," by S. R. Bergman, General Electric Co.

"Duplication of Electrical Side of Power Stations," by W. F. Sims, Commonwealth Edison Co.

Central heating plants, excepting in hospitals and a few other army stations where comfort without regard to cost is the primary consideration, are to be abandoned by the United States Army at all posts where physical conditions permit, and no more are to be installed. Tests have disclosed that central plants consume 40 to 200 per cent more fuel than is required to heat buildings by individual plants. Central plants now installed in officers' quarters may be retained if maintained at the personal cost of the officers.

Mechanical Stokers Sold from January to April, 1923

(According to the Bureau of the Census.)

Month	Number of Establishments Reporting	Number of Stokers Sold	Total Horsepower of Stokers Sold	Installed Under Fire-Tube Boilers		Installed Under Water-Tube Boilers	
				Total Number	Total Horsepower	Total Number	Total Horsepower
January.....	15	145	83,270	29	3,400	116	79,870
February....	15	129	66,619	9	1,172	120	65,447
March.....	15	120	68,955	9	1,259	111	67,696
April.....	15	167	85,339	14	2,000	153	83,339

Weights & Measures Officials Favor Standardizing Coal

Legislation in favor of fixing certain coal standards is favored by weights and measures officials from the various states who met in Washington last week at their annual conference at the Bureau of Standards. The resolution pointed out that there are no definite specifications as to coal quality or heat values of various varieties and no definite knowledge as to the effect upon coal when sheltered or exposed. The conference also favored the use of the net ton as a universal standard in the sale of coal.

Cherokee Bluffs Project To Start June 15

The Alabama Power Co., expects to begin operations by June 15 on the first of its Tallapoosa River projects, which will be the lowest location on the river and known as the Cherokee Bluffs project. A dam of 105 ft., 12 miles above Tallassee, Ala., will create a reservoir with a superficial area of 22,000 acres. The plans provide for initial installation of two 50,000-kva. units and the ultimate installation of another similar unit.

A total of 536 public-service generating stations in Great Britain is shown by the report of the "Electricity Commission" for the year ending March 31, 1922. Of this number 366 utilized steam as a source of power, 55 producer gas, 47 oil engines and the remainder other means, including water power. The Electrical Division of the Department of Commerce states that only seven stations depend exclusively upon water power, the largest of which produced 18,763,000 of the total of 29,107,000 kw.-hr., generated from this source. The total electric power generated during the year amounted to 4,884,666,038 kw.-hr., of which steam supplied power for approximately 97 per cent.

New Publications

Transformer Practice. By E. G. Reed. Published by D. Van Nostrand Co., New York, 1923. Cloth; 5½x7½ in.; 265 pages; 123 illustrations; 11 tables. Price, $3.

In this book is given a treatment of the theory, design and operation of the transformer from a practical engineering viewpoint, prepared primarily for the engineering student and the designing and operating engineer. The book is divided into twenty-five chapters, twelve of which are devoted to the design of transformers, one to the design of reactors, and twelve to transformer operation, three of the latter dealing with the cost of operation. The treatment throughout is largely mathematical and the work is therefore of limited use except to technically trained engineers and engineering students for whom it was written.

Principles of Chemical Engineering. By W. H. Walker, W. K. Lewis and W. H. McAdams (professors of chemical engineering at the Massachusetts Institute of Technology). Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City. Cloth; 6x9 in.; 637 pages; 156 illustrations. Price, $5.

This latest book on chemical engineering contains much of direct value to specialists in certain branches of power-plant engineering. Designing, consulting and research engineers, who are doing special work in such specialties as furnaces or boilers and other heat-transfer apparatus, will be interested in the extensive treatment of fluid films and the flow of heat. Other subjects having more or less application in the power field are: Furnace design, gas producers, crushing and grinding, humidity control and measurement, vaporization and evaporation. The book is one more illustration of the fact that the fields of mechanical, electrical and chemical engineering overlap to such an extent that he who would become expert in any branch must know something of all.

Obituary

Frank Edward Wing, treasurer of the L. S. Starrett Co., Athol, Mass., died at his home in that city on May 12 after a long illness. Mr. Wing was born fifty-seven years ago, in Conway, Mass., where he received his public school education, going later to Yale from which he received his B. S. in 1886. He has been connected with the firm of L. S. Starrett since graduation. He leaves a widow and a son, Donald Gordon Wing.

Dr. Hans Goldschmidt, inventor of the Thermit process for welding iron and steel and for producing high-grade metals and alloys, died suddenly in Baden-Baden, Germany, on May 20, 1923. He was born in Berlin in 1861 and received his education from the gymnasium of Altenburg, from Leipzig, Heidelburg, Strassburg and at the Institute of Technology at Charlottenburg. He visited this country frequently and was president of the Goldschmidt Thermit Co., now the Metal & Thermit Corp., from 1904 to 1916.

Water-Power Projects

An effort, is on foot, backed by local sentiment, looking to the development of a 37,500-hp. project in the vicinity of Charleston, S. C. The Columbia Railway & Navigation Co. proposes to construct a canal from the Santee River at a point near Ferguson to the Cooper River at a point near Moncks Corner, which will give a head of 55 ft. The project also involves some 20,000 acres for storage purposes and a navigation channel direct from Charleston to Columbia via the Congaree River. Such a canal existed in 1830 and carried a heavy commerce. The project depends on the amount of water that the federal government will authorize the applicants to divert from the Santee River. Georgetown, a seaport near the mouth of the Santee, is in opposition to the project because of the fear that the diversion would impair the navigation channel. The power company hopes to secure permission to divert all the water of the Santee with a proviso that whenever the Secretary of War directs, a minimum discharge of 3,000 cu.ft. per sec. will be allowed to pass which would meet the requirements of navigation were it established.

Application has been made by the Knoxville Power & Light Co., an Electric Bond & Share Co. property, for a preliminary permit covering the development of 200,000 hp. at four sites on the Clinch River. The application is in conflict with one of the Tennessee Hydro-Electric Company.

The project of the Cacapon Power Co. on the Cacapon River, near Martinsburg, W. Va., has been found to come within the jurisdiction of the Federal Power Commission. The project involves the erection of a dam 175 feet in height, which will provide 150,000 acre-feet of live storage.

The interests behind the Cacapon Power Co. are the same as those behind the Cheat River development. This Cacapon storage will be of great value in taking care of the peak loads on that system and in providing power during periods of minimum rainfall. This is one of the free storage sites relied upon by Major Max Tyler in his plan for the development of Great Falls on the Potomac.

Society Affairs

The **Philadelphia Sections** of the **A.S.M.E.** and the **A.I.E.E.** will hold their annual field day at McCall's Field on June 19.

The **Colorado Section** of the **A.S.M.E.** will hold a meeting at the Colorado Agricultural College at Ft. Collins, Colo., on June 8.

The **Atlanta, Ga., Section** of the **A.S.M.E.** will have a dinner dance and an election of officers at the Ansley Roof Garden, Atlanta on June 12.

The Engineering Section of the National Safety Council will hold its second meeting of the year at Detroit, Mich., in co-operation with the Detroit Safety Council on June 12.

The **Engineers' Society of Western Pennsylvania, Mechanical Section** and the **Pittsburgh Section** of the **A.S.M.E.** will hold a joint session at the William Penn hotel, Pittsburgh, Pa., on June 5. J. C. Hobbs manager of the Allegheny County Steam Heating Co. and L. W. Heller, general superintendent power stations, Duquesne Light Co., Pittsburgh, will speak on "Pulverized Fuel for Boilers."

Personal Mention

J. J. McNulta has resigned as chief engineer of the Vacuum Ash & Soot Conveyor Co., to take a similar position with the Girtanner Engineering Corp., 1400 Broadway, New York City.

Henry N. Winner, of Philadelphia, Pa., has just resigned as sales manager of the United States Rubber Co., to take the position of general manager of the Crandall Packing Co. He will also be the president and a director of the company.

Business Notes

B. P. Lientz & Co., engineers and manufacturers of oil furnaces and burners, have moved their offices from 291 Broadway, to their new building, 511 West 54th St., New York City.

The Conveyors Corporation of America, 326 West Madison St., Chicago, Ill., announces that the T. M. Grindley Co., 1158 Homer St., Vancouver, B. C., will handle the sales for the corporation in British Columbia.

Cole, Osgood & Kimball, 220 Devonshire St., Boston, Mass., is a new firm which will do a general engineering business, specializing in power plants, textile and industrial lines. Fred B. Cole and H. F. Kimball, for many years with Charles T. Main, of Boston, and H. E. Osgood, late New England representative of the Sanford Riley Stoker Co., are the partners in this new firm.

The Palmyra Packing Company was incorporated May 12, 1923, under the laws of the State of New York, with general offices and factories at Palmyra, N. Y. The officers of the company are president, John N. Todd, formerly with the Garlock Packing Co.; vice-president, Frank W. Coat; treasurer, Samuel H. Hunt; secretary, Charles McLouth. Several of these men have long been associated with the packing industry.

Trade Catalogs

Drums, Blowoff—New Haven Boiler Works, Inc., New Haven, Conn. Bulletin No. 10, Series 1, describes and illustrates the Webco Blowoff Drum for insuring the safe blowing off of high-pressure steam boilers.

Indicators, Hot Spot, For Transformers — Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Leaflet 3477-B, describes with photos and wiring diagrams how the indicator functions and how it is located in the transformer.

Heaters, Hot Water Service—The Patterson Kelley Co., 101 Park Ave., New York City. Catalog with reproductions and text describing the heaters and converters for industrial and domestic service. Useful tables of sizes, clearances and steam conversion are included.

Coming Conventions

American Boiler Manufacturers' Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Thirty-fifth Annual Convention at Hot Springs, Va., June 4-6.

American Institute of Chemical Engineers; Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Convention at Wilmington, Del., June 20-23.

American Institute of Electrical Engineers; F. L. Hutchinson, 29 West 39th St., New York City. Summer Convention at Swampscott, Mass., June 25-29.

American Order of Steam Engineers; W. J. Brice, 2126 S. 57th St., Philadelphia, Pa. 37th Annual Convention at Reading, Pa. (instead of Philadelphia, as formerly announced), June 4-8.

American Society for Testing Materials; C. L. Warwick, 1315 Spruce St., Philadelphia, Penn. Annual meeting at Atlantic City, N. J., June 25-30.

Association of Iron & Steel Electrical Engineers; J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Iron and Steel Exposition at Buffalo, N. Y., Sept. 24-28.

Canadian Association of Stationary Engineers; Gordon C. Keith, 51, Wellington St. West, Toronto, Canada. 34th Annual Convention at Toronto, Canada, June 25-28.

Electric Power Club; S. N. Clarkson, Kirby Bldg., Cleveland, Ohio. Annual meeting at Hot Springs, Va., June 11-14.

International Union of Steam and Operating Engineers; Dave Evans, 6334, Yale Ave., Chicago, Ill. Annual convention at Detroit, Sept. 10-15.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 914-25 East Jackson Blvd., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Illinois**, at Springfield, Ill., June 6-9; F. W. Raven, 417 South Dearborn St., Chicago. **New England States Association**, at Manchester, N. H., Manchester hotel, July 12-14; Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Iowa**, at Mason City, Iowa, June 11-14; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa. **Ohio**, at Dayton, June 21-23; J. H. Weaver, 22 N. Gift St., Columbus, Ohio. **Pennsylvania**, at Buffalo, Sept. 9-10; J. N. Calvert, Crafton Sta., Pittsburgh, Pa. **New York**, at Buffalo, Sept. 9-10; W. T. Meinzer, Third St., near Warburton, Bayside, L. I., N. Y. **Minnesota**, at Duluth, Aug. 8-10; C. A. Nelson, 800 22d Ave. N. E., Minneapolis. **Connecticut**, at Waterbury, June 29-30; L. Van Der Eyk, 251 Wood St., Waterbury.

National District Heating Association, D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, June 20-23.

National Electric Light Association; M. H. Aylesworth, 29 West 39th St., New York City. Annual meeting at New York City, June 4-8.

Ohio Electric Light Association, D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, July 10-13.

Smoke Prevention Association; Frank Chambers, 111 N. Dearborn St., Chicago, Ill. Convention at Minneapolis, Minn., June 19-22.

Society for the Promotion of Engineering Education; F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa. Annual meeting at Cornell University, Ithaca, N. Y., June 20-23.

Universal Craftsman Council of Engineers; John F. Amos, P. O. Box 299, Rochester, N. Y. Convention at Rochester, N. Y., Aug. 7-11.

Ejectors — Penberthy Injector Co., Detroit, Mich. Data sheet, "How to Select the Right Ejector," gives the sizes, types, operating conditions, installation conditions and service conditions with the catalog number of types of ejectors to be used with steam, air or water.

Machinery, Marine — Richardsons, Westgarth & Co., Ltd., Hartlepool, Middlebro', Sunderland, England. Booklet, "Propelling a Cargo Boat," by D. B. Morrison, M.I.N.A., tells the machinery story of the cargo boat and shows with handsome photo reproductions the engines, boilers, condensers, pumps, etc., that are installed on them by the manufacturers.

Engines—Western Machine Co., 900 North Main St., Los Angeles, Calif. Bulletin 100, describes and illustrates types "G" and "H", engines, 12 to 100 hp. single-cylinder; Bulletin 400 describes with photos, drawings and charts, the duplex and twin duplex engines, 80 to 320 hp. two and four cylinders; Bulletin 500, describes with blueprint drawings, photos and charts the Diesel engines of stationary and marine types, 25 b.hp., cylinders in multiples up to six.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	May 14, 1923	May 21, 1923
Pool 1,	New York	$3.50–4.00	$3.50–4.00
Smokeless,	Columbus	3.85–4.35	3.85–4.30
Clearfield,	Boston	2.25–3.25	2.25–3.00
Somerset,	Boston	2.75–3.50	2.75–3.25
Kanawha,	Columbus	2.00–2.40	2.00–2.40
Hocking,	Columbus	1.85–2.10	1.85–2.10
Pittsburgh No. 8	Cleveland	2.10–2.25	2.10–2.25
Franklin, Ill.,	Chicago	3.00–3.25	3.00–3.25
Central, Ill.,	Chicago	2.00–2.25	2.00–2.25
Ind. 4th Vein,	Chicago	2.75–3.00	2.75–3.00
West Ky.,	Louisville	1.85–2.00	1.85–2.00
S. E. Ky.,	Louisville	2.25–2.75	2.25–2.75
Big Seam,	Birmingham	1.85–2.25	1.85–2.25

FUEL OIL

(f.o.b. city unless otherwise specified)

New York—May 31, Port Arthur light oil, 22@25 deg. Baumé, 5⅜c. per gal.; 30@35 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

Chicago—May 26, 24@26 deg. Baumé, $1.97 per bbl.; 32@36 deg., $2.27 per bbl. tank cars.

Philadelphia—May 14, 26@28 deg. Baumé. Oklahoma, $1.10@$1.15 per bbl.; 30@34 deg., Oklahoma (group 3), 3⅛@3¼c. per gal.; 16@20 deg. Seaboard, $1.75@$1.90 per bbl.

St. Louis—May 22, tank-car lots, f.o.b. St. Louis; 24@26 deg. $1.90 per bbl., 26@28 deg., $1.95 per bbl.; 28@30 deg., $2.10 per bbl.; 30@36 deg., gas oil, 4¾c. per gal.; 36@40 deg., distillate 5¼c. per gal.

Pittsburgh—May 25, f.o.b. local refinery, 30@34 deg., fuel oil, 5⅜c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.; 34 deg., neutral, 9¼c. per gal.

Dallas—May 26, f.o.b. local refinery, 26@30 deg., $1.57 per bbl.

New Plant Construction

PROPOSED WORK

Calif., Fresno — The Stinson Irrigation Dist. will sell $360,000 bonds to finance improvements, including construction of canals and ten wells, also installation of pumps, motors, etc. Quinton, Code & Hill, Hollingsworth Bldg., Los Angeles, Engrs. Noted Mar. 6.

Calif., Huntington Beach—The California-Pacific Textile Co., Inc., T. Talbert, c/o Courthouse, Santa Ana, interested, plans to build a cotton mill, here. Cost will exceed $1,000,000.

Calif., Los Angeles—The Taft Realty Co., 5751 Hollywood Blvd., is having plans prepared for the construction of a 12 story store and office building on Hollywood Blvd. and Vine St. Cost will exceed $500,000. Walker & Eisen, Pacific Finance Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., Los Angeles—Walker & Eisen, Archts., Pacific Finance Bldg., representing syndicate, are preparing plans for the construction of a 13 story bank and office building. Cost will exceed $750,000. Equipment detail not reported.

Calif., Modesto—The Modesto Irrigation Dist., 823 11th St., will vote $57,000 bonds to finance construction and equipment as follows: twenty-six pumping plants and pipe, $46,400; artesian wells, $3,000; pipe line and Davis-Curtiss drains, $3,000; open drains, $2,600; equipment, etc., $2,000. P. Jones, Ch. Engr.

Calif., San Francisco—M. A. Little, c/o E. E. Young, Archt., 251 Kearny St., is having sketches prepared for the construction of a 12 story, 62 x 112 ft. apartment hotel. Estimated cost $500,000. Equipment detail not reported.

Calif., San Jose—The County of Santa Clara, H. A. Pfister, Clk. of Bd. of Supervisors, plans to build a refrigerating and ice making plant for the county hospital.

Calif., Santa Ana—The Santa Ana Valley Hospital Assn., Spurgeon Bldg., is having plans prepared for the construction of a 4 story hospital on Grand Ave. Estimated cost $250,000. H. N. Thornton, Hill Bldg., Santa Ana, Archt. Equipment detail not reported.

Conn., Hartford—The Street Bd. is having plans prepared for the construction of a small building with two centrifugal pumps to be operated by two 25 hp. electric motors for pumping sewage out of Colt Meadows. Estimated cost $25,000. R. N. Clark, City Engr.

Conn., Meriden—The Bd. of Public Wks. is in the market for an electrically driven centrifugal pump with appurtenances for installation in Kenmere Pumping Station. J. A. Toner, City Hall, Engr.

Conn., New Haven—The New Haven Orphan Asylum, c/o Norton & Townsend, Archts., 839 Chapel St., rejected bids and will have revised plans prepared for the construction of an orphanage on Whitney Ave. Estimated cost $500,000. Equipment detail not reported.

Conn., Southington—E. Rogers plans to build a 3 story cold storage plant. Estimated cost $45,000. Engineer or architect not selected.

D. C., Washington—Chief of Engineers, U. S. Army, will receive bids until June 15, for one 150 kw. and one 300 kw. Diesel engine generating sets, complete with auxiliaries and miscellaneous spare parts for each engine.

D. C., Wash.—J. A. Wetmore, Acting Supervising Archt., Treasury Dept., will receive bids until June 21, for furnishing and installing two horizontal fire box boilers at the United States Post Office, Scranton, Pa.

Fla., Starke—The City Bond Trustees will receive bids until June 26 for the construction of an addition to power plant and equipment, including two complete units to generate 75 kva. each, 3 phase, 2,300 volt, operated by crude oil combustion engine; one 15,000 gal. tank; 220 a.c. meters; 110 series street lights and brackets; one constant current transformer; fifteen potential transformers; one 100 ft. and one 150 ft. submerged type impeller pump and electric motor; one 150 ft. head centrifugal booster pump and electric motor; one 8 or 10 in. well about 500 ft. deep; one concrete reservoir, 50,000 gal. capacity. J. E. Craig, 427 King St., Jacksonville, Consult. Engr.

Ga., Savannah—Office of the U. S. Engineer, will receive bids until June 12, for two 15 in. dredging pumps.

Ind., Evansville—The City Council is in the market for one 500 g.p.m. wash water pump for filtration plant.

Ind., Evansville—The F. Miller Bakery & Ice Cream Co., 315 U 6th St., plans to build addition to bakery, ice cream factory and cold storage plant and to install refrigerating machinery. Cost will exceed $25,000. Engineer or architect not announced.

Ind., Kendallville—The city, H. H. Mortoroff, Engr., is in the market for a 750 hp. generator for addition to electric light plant.

Ky., Louisville—The Louisville Ry. Co., 314 West Jefferson St., J. Barnes, Pres., plans to build a 100 x 400 ft. terminal and office building on 2nd and Liberty Sts. Estimated cost $1,000,000.

Ky., Louisville — The Office of United States Engineer, P. O. Box 72, is in the market for one steam pump, horizontal, duplex, double acting, piston pattern, 150 lb. steam pressure, steam cylinder, 6 in. diameter, water cylinder, 4 in. diameter, stroke 6 in., or similar type.

Ky., Louisville — The Southern Baptist Theological Seminary, Norton Hall, 416 West Broadway, C. S. Gilbert, Registrar, plans to build a seminary on a 51 acre site on Cherokee Dr. Estimated cost $1,700,000. Engineer or architect not selected.

Ky., Louisville—The United Theatres Co., 5th St., managers of local B. F. Keith theatres, plans to build a 12 to 15 story, 150 x 220 ft. theatre and office building. Estimated cost $3,000,000. Engineer or architect not selected.

Ky., Maysville—The Glascock Dairy & Ice Cream Co. plans alterations to its plant and the installation of refrigerating equipment. Cost of equipment will exceed $1,000.

Ky., Owensboro—J. A. Bolger is in the market for power house equipment.

Ky., Williamsburg—The Rex Harlan Coal Co., T. E. Mahan, Pres., is in the market for electrical power equipment and mining machinery for local mines here.

La., Mamou—J. S. Guillory, Mayor, and Bd. of Aldermen are receiving bids for the construction of water works plant, consisting of oil engines, pumps, steel tower and tanks, fire hydrants, valves, water pipe pump, reservoir, well, etc. Estimated cost $40,000. Kraemer Eng. Co., Magnolia, Miss., Engrs. H. E. Mentz, Managing Engr.

Md., Baltimore — J. L. Barr, Consult. Engr., 202 North Calvert St., is receiving bids for a 9 x 9 in. belt driven ammonia compressor, complete with double pipe ammonia condensors receiver and high pressure trap, either York or Frick (used).

Md., Baltimore—The Chesapeake & Potomac Telephone Co., 725 13th St., N. W., Wash., D. C., A. E. Berry, Pres., is having plans prepared for the construction of a 20 story office building on St. Paul and Pleasant Sts., here. Estimated cost $2,000,000. Private engineering plans. Stern & Tomlinson, Continental Trust Bldg., Wash., D. C., Archts. Equipment detail not reported.

Mass., Holyoke—The city plans to expend about $500,000 for renovating the municipal electric lighting plant and installing new equipment. Noted May 1.

Michigan—The state legislature has made appropriations as follows: (a) 1924, (b) 1925. The University of Michigan, Ann Arbor, hospital (a) $800,000 (b) $1,500,000; medical building (a) $500,000 (b) $200,000; heating tunnel for hospital (a) $90,000; heating tunnels and sewers (a) $120,000 (b) $90,000; power plant (a) $250,000 (b) $250,000. The Agricultural College, East Lansing, power house extension (a) $75,000 (b) $75,000. Kalamazoo State Hospital, heating plant (a) $57,200 (b) $57,200. Marquette Prison, boiler house (a) $70,000.

Mich., Niles—Nicol, Scholer & Hoffman, Archts., Lafayette, Ind., will receive bids June 15 for the construction of a 5 story hotel on a 132 x 191 ft. site on Main St., for T. W. Ready, c/o Ready Capsule Co., here. Estimated cost $250,000. Equipment detail not reported.

Minn., Minneapolis—J. H. Davidson, 723 Plymouth Bldg., is having plans prepared for the construction of a 12 story, 165 x 165 ft. apartment hotel, including steam heating system, on 11th St. and Marquette Ave. Estimated cost $2,500,000. A. Rose, 1000 Builders Exch., Minneapolis, Archt.

Minn., St. Cloud—Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until June 13 for the construction of hospital buildings and tunnnels; plumbing, heating and steam distribution system; lighting and power systems, telephone conduits; boiler house, including equipment and piping; cold storage building and equipment, here. Noted May 22.

Mo., Gl. —The city defeated $40,000 bonds for the construction of electric light plant and distribution system, also $25,000 bonds for waterwork pumping, storage and distribution system. It is planned to resubmit proposition to voters soon. Noted May 8.

Mo., St. Louis—The St. Louis-San Francisco Ry., Frisco Bldg., J. G. Jonah, Ch. Engr., will receive bids until June 6 for the construction of a 20 stall roundhouse, car repair shop, machine shop, power plant, mill shop, two wash and locker rooms, etc., on Fyler Ave. and Frisco right-of-way, Lindenwood. Estimated cost $500,000. R. C. Stephens, Frisco Bldg., Archt. Noted Mar. 13.

N. Y., Brooklyn—Trinity Hospital, Fulton St. and East New York Ave., is having sketches made for the construcion of a 5 story addition. Private plans.

N. Y., New York—The Dept. of Plant & Structures received bids for furnishing and installing automatic substation equipment for City Island Trackless Trolley Line, Borough of the Bronx, from Westinghouse Electric Mfg. Co., 165 Broadway, New York, $31,990; Genl. Electric Co., 120 Broadway, New York, $38,000. Noted May 22.

N. Y., New York—The Dept. of Pub. Welfare, Municipal Bldg., received bids for the construction of a refrigerating annex and alteration of the refrigerating plant at Sea View Hospital, Borough of Richmond, from L. C. Smith, Times Bldg., $32,235; W. W. Constr. Co., 51 East 42nd St., $38,835; P. T. Cox Contg. Co., 154 Nassau St., $43,800. Noted May 22.

N. Y., Utica—The Utica Hygeia Ice Co., Inc., c/o C. A. Schmidt, 1124 Pleasant St., plans to build an artificial ice plant on Wurz Ave. Estimated cost $75,000, machinery $15,000. The owner is in the market for machinery and equipment.

N. C., Hendersonville—S. E. Stahler, Box 1231, is in the market for refrigeration and ice making machinery and equipment.

N. C., Raleigh — The Raleigh Bldg. & Loan Assn., J. C. Allison, Secy., 107 Fayetteville St., will receive bids until June 12 for the construction of an 11 story office building. H. P. S. Keller, Raleigh, Archt.

Ohio, Cleveland — The Atlas Properties Co., c/o H. Himmel, Pres., 1006 Schofield Bldg., is having plans prepared for the construction of an 11 story commercial and apartment building, including steam heating system, at 1938 East 105th St. Estimated cost $700,000. E. McGeorge Co., 1900 Euclid Ave., Cleveland, Archt.

Ohio, Cleveland—The Brotherhood of Locomotive Engineers, W. S. Stone, Pres., Engineers Bldg., is having plans prepared for the construction of a 20 story, 132 x 168 ft. bank and office building on Ontario and St. Clair Aves. Estimated cost $5,000,000. Knox & Elliot, 906 Engineers Bldg., Archts. C. M. Clark, Engineers Bldg., Engr. Noted Oct. 10, 1922.

Ohio, Cleveland—The Natl. Dept. Stores Co., c/o V. Sincere, of the Bailey Co., Pres., is having sketches prepared for the construction of a 10 story, with foundation for 20 story, department store, including steam heating system, on East 9th St. and Euclid Ave. Estimated cost $2,500,000. A. Garfield, City Hall, Cleveland, Archt. Noted May 1.

Ohio, Cleveland—The St. James Apartments, c/o M. Marmorstein, 607 Ulmer Bldg., are having plans prepared for the construction of a 10 story apartment building, including steam heating system, on East 89th St. and Euclid Ave. Estimated cost $750,000. S. H. White, 1030 Schofield Bldg., Cleveland, Archt.

Ohio, Columbus—The Dept. of Welfare, J. E. Harper, Dir., 9th and Oak Sts., will receive bids until June 16, for the construction of a 48 x 115 ft. cold storage plant and all refrigeration equipment.

Okla., Oklahoma City—W. B. Skirwin, Skirwin Hotel, 1st St. and Broadway, is having plans prepared for the construction of a 13 story, 100 x 140 ft. addition to hotel. Estimated cost $5,000,000. Layton, Smith & Forsyth, S. W. Natl. Bldg., Oklahoma City, Archt. Equipment detail not reported.

Ore., Salem—Grant, Smith & Co., Ry. Exch. Bldg., Portland, have filed applications with the state engineer covering two power sites on the Deschutes River, one in

Sherman County and the other in Wasco County. At the Sherman County site it is planned to divert 3,500 sec. ft. of water for the development of 40,000 hp. About 29,000 hp. will be developed at the Wasco County site. Total estimated cost $8,000,000.

Pa., Greensburg—The Fisher Traffic Co., T. Fisher, Mgr., is in the market for electrically operated ice manufacturing machinery and equipment, including ammonia tanks, compressors, etc., for proposed plant at New Castle.

Pa., Newcastle—The Scottish Rite Bodies, F. & A. M., are having plans prepared and will probably receive bids about June 11 for the construction of a temple on Hiland and Lincoln Sts. Estimated cost $1,000,000. R. G. Schmid, 152 West Randolph St., Chicago, Archt. Equipment detail not reported. Noted June 6, 1922.

Pa., Pittsburgh—The Southfield Methodist Episcopal Church, 7th Ave. and Southfield St., is having plans prepared for the construction of a 20 story, 60 x 110 ft. church and office building. Estimated cost $1,000,000. E. Stotz, Monongahela Bank Bldg., Pittsburgh, Archt. Equipment detail not reported.

Tenn., Chattanooga—The Masonic Temple Assn. has purchased site and plans to build a 14 story, 80 x 100 ft. lodge and office building on Cherry and East 7th Sts. Estimated cost $750,000.

Tex., Fort Worth—The city, J. C. Lord, Water Comn., is having plans prepared and will soon receive bids on a 12,000,000 gal. per day pump and miscellaneous machinery for Holly pumping plant. Estimated cost $80,000. D. L. Lewis, City Engr.

Tex., Fort Worth—The Southwestern Portland Cement Co., Two Republic Bldg., El Paso, is having plans and surveys made for the construction of a dam across Sycamore Creek, 600,000 gal. daily capacity, concrete spillway, etc., estimated cost $250,000; cement mill, here, estimated cost $1,500,000. J. B. Hawley, Cotton Exch., Fort Worth, Engr.

Tex., Galveston—The city voted $125,000 bonds and is having plans prepared for rebuilding Alta Loma pumping plant and extensions. C. A. Holt, Jr., City Engr.

Tex., Houston—The city, O. F. Holcombe, Mayor, has had plans prepared and will vote on a $1,750,000 bond issue, June 9 for the construction of a 19 story, 170 x 237 ft. municipal, market, office building and city hall on Travis St. R. J. Cummins, 214 Gulf Bldg., Houston, Engr. C. D. Hill & Co. and J. W. Dehnert, 501 Kress Bldg., Houston, Archts. Equipment detail not reported.

Va., City Point—Wilson-Hock Co. (machinery dealers), N. Wilson, Mgr., is in the market for two 50 hp., 3 phase, 60 cycle, 220 volt motors, one squirrel cage and one slip ring; water tube boiler, about 300 hp., 200 lb. working pressure for fuel oil burners; two 3 phase, 60 cycle, 250 r.p.m., 750 hp. slip ring motors with starting equipment, 230 or 550 volt; 4 in. c. i. B. & S. water pipe and fittings; two fuel oil storage tanks, about 8,000 gal. capacity, each; one gasoline storage tank, 20,000 to 30,000 gal. capacity, $\frac{5}{16}$ in. plate; tower tank, 40 to 50 ft. high, about 35,000 gal. capacity; three transformers, 100 kva., single phase, 60 cycle, 2,200 volt high tension, 550 volt low tension.

Va., Yorktown—The Bureau of Yards & Docks, Naval Marine Depot, Wash., D. C., will receive bids until June 20, for power plant equipment.

Wis., Cambridge—The Bd. Educ., L. C. Banker, Supt., plans to build a 1 story heating plant for school buildings. Estimated cost $50,000. Engineer or architect not selected.

Wis., Fond du Lac—St. Agnes Hospital, M. Marcello, Mgr., 309 East Division St., is having plans prepared for the construction of a power plant. Estimated cost $45,000. R. E. Schmidt, 104 South Michigan Ave., Chicago, Ill., Archt. Power equipment, including generator, ash handling machinery, etc., will be installed. Noted May 29.

Wis., Madison—The Chicago & Northwestern Ry., East Madison St., A. W. Bowers, Divisional Agt., 201 South Blair St., is having plans prepared for the construction of a 1 story, 60 x 200 ft. power house and machine shop. Estimated cost $150,000. Private plans. The owner is in the market for electric power machinery, etc.

Wis., Madison—The Piper Bros. Grocery Co., 31 North Pinckney St., is having plans prepared for the construction of a 4 story, 60 x 90 ft. store and warehouse building, including steam heating system, on Mifflin St. Estimated cost $150,000. Balch & Lippert, Gay Bldg., Madison, Archts. The owner is in the market for refrigeration equipment, ice machines and conveyors.

Wis., Madison—M. Tullgren & Sons Co., Archts., 425 East Water St., Milwaukee, will receive bids until June 10 for the construction of a 9 story, 132 x 144 ft. hotel on West Washington and Fairchild Sts., here, for the Hotel Wisconsin Realty Co., 86 Michigan St., Milwaukee. Estimated cost $1,000,000. Equipment detail not reported. Noted May 22.

Wis., Marshfield—The S. Miller Fruit Co., S. Miller, Mgr., is in the market for ice machine and refrigeration machinery, also belting and shafting.

Wis., Oshkosh—The City, A. C. McHenry, Mayor, is receiving bids for furnishing and installing pumping machinery for waterworks pumping station. B. T. Gifford, Gay Bldg., Madison, Engr. Noted Feb. 27.

Wis., Wauwatosa—Cahill & Douglas, 217 West Water St., Milwaukee, is receiving bids on a steam jet ash conveyor, for the Forsyth Leather Co., State St. Noted Mar. 20.

Wis., Wisconsin—Waushara County, N. H. Beirag, Chn. Court House, will receive bids until June 29 for the construction of a steam heating plant to furnish heat for court house, jail and county garage. Estimated cost $25,000. Private plans.

Ont., Chatham—The Pub. Utilities Bd., B. L. Bedford, Chn., is in the market for a 1,500 kva. transformer for substation.

Ont., Eugenia—The Ontario Hydro Comn., A. Beck, Chn., 169 Albert St., will have estimates prepared for connecting Niagara with Eugenia plant, increasing capacity of the plant at Eugenia Falls, building new pipe line and installing frequency changer and other equipment. Estimated cost $75,000.

Ont., Kirkland Lake—The Wright Hargreaves Mines, Ltd., plan to increase capacity of gold mining mill from 70 ton to 400 or 500 ton per day. Equipment will include crushers, stamp mills, tube and ball mills, pumps, electric motors, etc.

Ont., Trent River—The Hydro Electric Power Comn., W. W. Pope, Secy., 190 University Ave., Toronto, plans the construction of a power house foundation and tailrace excavation at dam No. 8. Cost about $400,000. Noted May 22.

Que., Mont Joli—The Canada & Gulf Terminal Ry., J. E. Pinault, Genl. Supt., is in the market for an 8 x 8 vertical steam engine.

T. H., Pearl Harbor—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until June 25 for refrigerating equipment, consisting of motor driven compressor, condenser, liquid receiver, brine cooler, motor driven brine pump, oil and scale traps, piping etc. Alternate, self-contained, hermetically sealed refrigerating machine or on a direct expansion system in lieu of the brine circulating system. Noted Mar. 27.

CONTRACTS AWARDED

Ala., East Thomas (Birmingham P. O.)—The St. Louis-San Francisco Ry., 900 Olive St., St. Louis, Mo., awarded the contract for the construction of a 20 stall round house, car repair shop, power house, mill shop, store room, etc., here, to J. M. Olsen, 626 Delmar St., Springfield, Mo. Estimated cost $500,000. Noted Mar. 13.

Conn., New Britain—The Amer. Hardware Corp., P. and F. Corbin Division, Park St., awarded the contract for the construction of a 2 story, 15 x 80 ft. power plant to the W. H. Allen Co., Hungerford Court, New Britain. Estimated cost $50,000. Noted May 29.

Ill., Chicago—The Austin Hospital Assn., Austin (Chicago, P. O.), awarded the contract for the construction of a 6 story, 120 x 200 ft. hospital on Central and Flournon Sts., here, to the R. Solitt & Sons Constr. Co., 5 North La Salle St., Chicago. Estimated cost $400,000. Steam heating system will be installed.

Ky., Bowling Green—The Morehead Hotel awarded the contract for the construction of a 4 story hotel to contain 120 rooms, to the Forbes Mfg. Co., Hopkinsville. Estimated cost $300,000. Equipment detail not reported.

Mass., Holyoke — The Farr Alpaca Co. awarded the contract for the construction of a 1 story, 63 x 72 ft. power plant on Jackson St. to D. O. Connell, 480 Hampden St., Holyoke. Estimated cost $30,000.

Minn., Minneapolis — The State Bd. of Control, D. F. Mullen, Secy., Capitol, St. Paul, awarded the general contract for the construction of a 3 story electrical building at the State University, here, to Carlsted Bros., 542 Builders Exch., Minneapolis. Estimated cost $258,843. Noted May 15.

N. H., Gorham—The Twin State Gas & Electric Co., 160 State St., Boston, Mass., awarded the contract for the construction of a 42 x 62 ft., hydro-electric generating plant here to the Sanders Engineering Co., Portland, Maine. Estimated cost $250,000. Machinery and equipment has not been purchased.

N. J., Camden—The Bell Telephone Co., 19th and Arch Sts., Phila., awarded the contract for the construction of a 5 story, 136 x 140 ft. telephone building on 7th and Federal Sts., here, to I. E. Leighton, 126 North 12th St., Phila. Estimated cost $1,000,000. Equipment detail not reported.

Ohio, Cleveland—The Schonberg Printing Co., 102 St. Clair Ave., N. W., D. Schonberg, Pres., awarded the contract for the construction of a 1 story, 50 x 129 ft. and 20 x 25 ft. factory, boiler house and garage, including steam heating system, on East 25th St. and Payne Ave. to the A. A. Lane Constr. Co., 1869 East 55th St., Cleveland. Estimated cost $50,000.

Ohio, Painesville—The city, T. B. Wyman, Mgr., awarded the contract for the construction of foundation and concrete work to H. C. Felver, 7016 Euclid Ave., Cleveland, $19,450; boiler, Erie City Iron Wks., Erie, Pa., $8,740; stokers, Amer. Eng. Co., Aramingo Ave. and East Cumberland St., Phila., Pa., $6,580; chimney, A. Custodis Chimney Co., Guard Bldg., Cleveland, $7,850. Noted May 15.

Pa., Kingston (Wilkes-Barre P. O.)—The Glen Alden Coal Co. awarded the contract for the construction of an 85 x 90 ft. boiler plant with 32 x 69 ft. ell at its Pettebone Colliery, to the Turner Constr. Co., 11 Goodell St., Buffalo, N. Y.

Tex., Austin—The Baker Hotel Corp., San Antonio, awarded the contract for the construction of an 11 story hotel on 7th and Congress Sts. to J. P. Haynes, Moore Bldg., San Antonio, $469,000; elevators, Otis Elevator Co., 7th St., Fort Worth, $41,000; mechanical equipment, J. L. Martin, 412 Congress Ave., Austin, $180,000. Noted Mar. 6.

Tex., Dallas — The Dallas Textile Mills Co., J. P. Burrus, Interurban Bldg., Pres., awarded the contract for the construction of a textile mill to the Inge Constr. Co., Swiss and Hawkins Sts. Estimated cost $1,000,000. Noted May 22.

Tex., Dallas—The Higginbotham Bailey Logan Co., Jackson St., awarded the general contract for the construction of a 7 story, 75 x 200 ft. loft building on Jackson and Poydres Sts. to Hickey & Montgomery, Scollard Bldg., Dallas. About $400,000. Five elevators, heating system, oil fuel, sprinkler system, etc., will be installed. Lang & Witchell, Amer. Exchange Natl. Bank, Dallas, Archts.

Tex., Granbury—The city, N. Hiner, Secy., awarded the contract for the construction of waterworks and electrical work, including two crude oil engines, alternators, two centrifugal motor driven pumps, c.i. pipe, steel tank, etc., to the Municipal Eng. Co., Praetorian Bldg., Dallas. Estimated cost $75,000. Noted May 1.

Tex., Rule — The City Comn., D. Crockett, Clk., awarded the contract for the construction of a 50,000 gal. steel tank and tower, pump house, machinery, 33 fire hydrants, miscellaneous valves and c. i. pipe to the Pittsburgh Des Moines Steel Co., Sumpter Bldg., Dallas, about $50,000. Noted Mar. 6.

Vt., Whitingham — The New England Power Co., 50 Congress St., Boston, awarded the contract for the construction of a 1 story, 40 x 50 ft. hydro-electric power station to contain two turbine generators, here, to L. H. Shattuck, 208 Granite St., Manchester, N. H. Estimated cost $25,000.

Wis., Milton—The city awarded the contract for deep well water mains, pump house, reservoir, etc., to the W. H. Deason Co., 355 Washington Bldg., Madison; centrifugal pumps, Dayton Dowd Co., Quincy, Ill.; 40,000 gal. tank and 70 ft. tower, Pittsburgh Des Moines Steel Co., 38 South Dearborn St., Chicago, Ill.

Wis., La Crosse—The Weisse Mfg. Co., Caledonia & Gilett Sts., will build by day labor, a 1 story, 70 x 209 ft. millworking factory, boiler house and shaving vault. Estimated cost $75,000. Noted Apr. 3.

Wis., Milwaukee—The Hotel Medford, 3rd and Sycamore Sts., awarded the contract for the construction of a 4 story, 75 x 120 ft. addition to B. Wilke, 1011 Island Ave., Milwaukee. Estimated cost $400,000. Equipment detail not reported. Noted Mar. 13.

Wis., Milwaukee—The Western Leather Co., 878 Marshall St., awarded the contract for the construction of a 1 story, 40 x 110 ft. boiler house to A. W. Riesen, 409 Broadway, Milwaukee. Estimated cost $65,000. Noted May 22.

Wis., Woodville—The city awarded the contract for a deep well pump in connection with waterworks system, to the Chippewa Pump Co., Chippewa Falls. Estimated cost $1,600. Noted May 1.

Que., Montreal—The Drummond Apartments, Ltd., P. R. DuTremblay, Pres., awarded the contract for the construction of a 10 story, 214 x 252 ft. apartment house on Drummond St. to Anglin-Norcross, Ltd., Victoria St. Estimated cost $5,000,000. Noted Mar. 27.